6.0 Traveler Surveys and Focus Groups

6.1 Analysis Objectives

The primary objective of the market research analysis was to assess changes to the individual traveler perspective on ramp metering following the ramp meter shutdown. Insights on travelers' behavior and attitudes toward ramp metering would help to identify the strengths and weaknesses of the ramp metering system as viewed by individual travelers. Such insights would support the design of the system and the decision-making process regarding its future.

The survey data collection and the statistical analysis approach were structured to obtain the socioeconomic, travel, and attitudinal information that would most effectively allow the evaluation team to "listen to consumers" and quantify their reactions to ramp metering. The analysis tried to answer the following questions:

- What is the socioeconomic profile of travelers in the random sample and the respondents in each of the corridor samples?
- Are there any important differences in the socioeconomic characteristics of respondents in the "with ramp meters" and "without ramp meters" surveys that require us to treat the two waves as different?
- What are the travel characteristics of respondents in each survey and how do they differ across the four corridors and between the "with ramp meters" and "without ramp meters" survey waves?
- Did the ramp metering shutdown have an impact on travelers' everyday travel patterns? Has the shutdown caused a shift in respondents' travel patterns and has it also affected the way they view the usefulness of the ramp meters?
- What are travelers' attitudes toward their everyday commute and, in particular, how do travelers view the ramp metering system and its impact on their everyday travel? Are travelers' attitudes consistent with their own travel experiences with ramp metering and are they in agreement with the traffic and travel time data?
- Following the ramp meter shutdown, do travelers believe they are better or worse off regarding the total origin-destination travel time, the time spent on the freeway, and the overall traffic conditions that they face?

- How has the meter shutdown affected travelers' attitudes toward ramp meter operations? Are there any important differences by market segment and by corridor indicating different reactions to the ramp meter shutdown that need to be taken into account?

- What are travelers' opinions about the ramp meter operations? Do travelers want to see the system operating "as is," modified in some way, or shut down permanently? Has their opinion changed after their experience with the ramp meter shutdown?

The second objective of the market research effort was to complement the traffic and travel time analysis described in earlier sections of this report. The collection of survey data was conducted along the same freeway corridors for which traffic and travel time data were collected (see Figure 4.1). Therefore, the joint analysis of the surveys and the traffic and travel time sources allows the market research findings to support the interpretation of the traffic and travel time analysis findings.

To meet these objectives, the data collection and analysis approach consisted of the following steps that are described in detail in this section:

- **Focus groups** of area residents were conducted to obtain qualitative insights into travelers attitudes toward ramp metering and to help design the surveys;

- **The sampling frame** consisted of a random sample of residents in the seven-county metro area and a collection of license plate numbers from users of the four corridors under study – two separate samples were developed for the before and after surveys;

- **Traveler surveys** were designed to extract the travel patterns, attitudes, and suggestions of area travelers using a combination of a random sample and four corridor-specific samples;

- A **"with/without" comparative** analysis was made possible by collecting data on traveler behavior, attitudes, and suggestions both before and after the ramp meter shutdown; and

- The **statistical analysis** of the two survey waves emphasized the identification and measurement of statistically significant "with/without" differences across corridors and market segments.

■ 6.2 Section Outline

This section discusses in detail the statistical analysis and interpretation elements for each of the steps in the market research effort. This discussion builds on the evaluation methodology described in Section 4.3 that outlined the focus group structure, summarized the sampling frame for the surveys, and presented the design of the "with ramp meters" and "without ramp meters" surveys.

The focus group findings are summarized in Section 6.3.1. The discussion is structured around the objectives of each focus group, the questions that were addressed, and the conclusions that were reached during each phase.

Section 6.3.2 focuses on the quantitative market research task by discussing briefly the statistical analysis tools and tests that were used to identify and measure the statistical significance of differences uncovered during the analysis. Section 6.3.3 concludes the analysis approach by outlining the research questions that were explored. This set of research hypotheses serves as an introduction to the empirical analysis that is described in this section.

Section 6.4 provides the first set of empirical results from the traveler survey analysis. The focus is on the descriptive analysis of the socioeconomic characteristics and the identification of differences both across corridors and across the two waves of the analysis. A similar approach is undertaken for the analysis of travel patterns under Section 6.5.

Summaries of travel behavior characteristics for the random sample and across the different corridors are provided to help understand the different travel contexts faced by travelers. A comparison of respondents' travel patterns before and after the shutdown and travelers' own assessment of how the shutdown experiment affected the travel times and traffic conditions they face helps to identify whether the ramp meter shutdown had a significant impact on traveler behavior. An in-depth analysis of travelers' experiences, specifically with the ramp meters, is provided under Section 6.6. Travelers' average wait time at the meters and their willingness to wait are addressed.

Section 6.7 presents the analysis of traveler attitudes toward their overall travel and then focuses on traveler attitudes that are directly related to ramp metering. Statistically significant differences are identified across market segments and corridors. Section 6.9 discusses differences that are attributable to the ramp meter shutdown experiment by combining the corridor and market segment comparisons with a "with/without" analysis of travelers' attitudes.

The analysis concludes in Section 6.10 by assessing travelers' preferences toward the continuation of the ramp meter system operation. Travelers' response to a polling question that examined whether respondents supported the continuing operation of the ramp meter system is summarized, along with respondents' suggestions for changes to the ramp meter system that they would like to see implemented in the future.

6.3 Overview of the Analysis Approach

6.3.1 Focus Group Findings

The discussion in this section summarizes the synthesis of the results emanating from qualitative research conducted among freeway travelers within the Minneapolis/St. Paul metropolitan area. These results provided an initial understanding of travelers' attitudes toward the ramp meter shutdown, and inputs to the survey design and statistical analysis.

These augmented our understanding of travelers' attitudes toward the operation of ramp meters in the region's freeway system, including travelers' opinions about ramp meters in general; the types of benefits ramp meters may or may not provide; and how the existence of ramp meters affects route, mode, and departure time choice decisions. An extensive discussion and presentation of the qualitative research findings from the focus groups is included in Appendix I.

During each focus group session, the moderator introduced topics, probed for comments, and elicited reactions from all of the participants, while maintaining a non-directive style of interviewing to avoid biasing any discussions. Participants were encouraged to speak freely, interact, and offer dissenting opinions, whenever possible, on each of the issues. The sessions were conducted at a professional focus group facility with a one-way mirror to permit the observation of participants by members of the Technical and Advisory committees, consultant staff, and Mn/DOT staff.

6.3.1.1 "With Ramp Meters" Focus Groups

The discussion topic guide that was developed included the following general topics for discussion during each focus group:

- Introduction by the moderator of the purpose of the discussion and the ground rules for participation in the discussion,
- General perceptions toward ramp meters,
- Awareness of ramp meter benefits,
- Evaluation of ramp meter performance and measures of effectiveness,
- Attitudes and expectations toward the ramp meter shutdown, and
- Information needs for the ramp meter shutdown.

General Ramp Meter Perceptions

The mention of ramp metering was initially met with considerable negative reaction, although participants made a distinction between their experiences waiting at ramp meters and traveling on the region's freeway systems. They believed that there were too many ramp meters in the metro area and were frustrated with the long wait times at the meters. Participants appeared resigned to the fact that metering has become a way of life for travel in the region, and recognized that the traffic on freeways flowed much better in the Twin Cities area potentially as a result of ramp metering. Ramp metering was perceived as making travel more predictable in terms of the time it took to get to their destination once on a freeway, although the wait times at the meter and the back-up occurring on the ramps themselves were considered to be the most unpredictable portion of any given trip.

Travelers were very knowledgeable about the roadway network and very adept in terms of planning which specific routes to take during peak morning and afternoon travel periods and often relied on traveler information from radio or television. Their experience with the behavior of specific ramp meters at different times of the day had a direct impact on travelers' route choice.

Awareness of Ramp Meter Benefits

Participants in both groups were unable to remember when ramp meters were first installed and the rationale behind their installation. There was a significant lack of justification for ramp metering, since it seemed to have occurred long ago and was not perceived as helping to increase the "quality of commuting life." When participants in the two groups were able to cite specific benefits associated with ramp metering, the majority of comments given pertained to "reducing congestion" and "safety" issues. Specifically, it was mentioned that metering served to help traffic flow on the freeways, which, in turn, allowed motorists to maintain adequate speeds and distances between vehicles. Also, meters appear to decrease the potential for accidents, since they provide a means to ease the merging of ramp traffic entering the freeway.

However, when specific benefits were provided on an aided basis (i.e., provided by the moderator), most participants agreed that the meters were indeed very beneficial to travelers. The benefits that resulted in the most positive reactions related to:

- Aids in merging traffic onto a freeway in a safe and orderly manner,
- Serves to increase speeds and the flow of traffic once on the freeway,
- Helps to conserve gas and expenses,
- Improves air quality and the environment, and
- Reduces roadway stress and anxiety once on the freeway.

Interestingly enough, there was considerable debate over the merits of the last three benefits cited above and participants made a clear distinction between the potential for reducing road rage on the freeways, but not always on the ramps, since wait times could be very frustrating for most travelers. After discussing these specific benefits, participants felt a little better and perhaps less negative about ramp metering in general.

Ramp Meter Performance Measures

None of the participants mentioned having problems with the actual operation of ramp meters since they were perceived as being well-maintained and fully operational most of the time. However, participants thought that the time spent waiting at a ramp meter had no association with the amount of traffic on the freeway itself. There appeared to be no degree of consistency between the wait times experienced even across adjacent meters, and there didn't seem to be a clear relationship between freeway traffic and ramp meter wait times. Given this apparent inconsistency, it was not clear to participants whether the wait times were centrally controlled and adjusted.

Overall, waiting times of two to five minutes were very acceptable to most participants, with wait times of five to eight minutes still tolerable, and anything over 10 minutes considered to be quite frustrating. In addition to problems with wait times, back-ups on many of the more heavily-traveled ramps meters were also cause for concern and were viewed as yet another source of frustration. Travelers would like to have either longer ramps or some advanced notification of wait times before entering a ramp. This latter idea was very appealing to participants since it provided them with information that could be used to make a decision about using a particular ramp meter just as long as an electronic message sign was located a sufficient distance before the entrance.[1] Lastly, the use of by-pass lanes for high-occupancy vehicles (HOVs) (or commonly referred to as "sane lanes") as a means to avoid ramp meters altogether was not considered to be very useful by the majority of participants.

Attitudes Toward the Ramp Meter Shutdown

At the time, most of what participants had heard about the shutdown came from articles in the newspaper or by word-of-mouth. Among those participants who remembered hearing or reading something about the shutdown, the media's description of it was felt to be more factual in content rather than opinioned and biased.[2]

Participants were also asked what concerns, if any, they would have about such a shutdown of the region's ramp meters. The most common reaction was that it would wreak havoc on travel in the region. Most participants stated that, except for leaving a little earlier in the morning, they would not change their travel routes or stay at home during the first few days of the experiment should it actually occur. They indicated that they would continue with their usual routines and wait to see what happens before making plans to use alternate routes. Also, when asked whether they would be more likely to rideshare or take public transportation, they stated that they would be highly unlikely to do so.

Information Needs for Ramp Meter Shutdowns

In an effort to understand how information about the impending shutdown should be conveyed to the general public, participants were asked what they would like to know about it and the best way to inform them. Participants generally agreed that they would like to be notified anywhere from 10 to 14 days in advance of the event in order to make adjustments to their schedules.

With regard to what information they would like to have available from Mn/DOT to be able to judge the impact of such a shutdown, participants were very clear about their needs. Interestingly, information pertaining to traditional traffic performance measures

[1] In 1998-1999, Mn/DOT conducted a test of ramp meter wait signs which provided real time estimates of wait times at ramps where travelers would not be able to see the length of the queue. These signs were deployed by the Orion Program to test the costs and benefits of new forms of Intelligent Transportation Systems (ITS) technologies. An evaluation conducted by Cambridge Systematics, Inc. for Mn/DOT found wide consumer acceptance and enthusiasm for the signs and, in some cases, use of the information to adjust route choice. Further deployment of the signs has been deferred due to operational issues.

[2] The focus group was conducted in September 2000. While there had been considerable general discussion in the media for the previous several months following the enactment of legislation in the spring of 2000 mandating the shutdown, no specific information regarding the timing or details of the shutdown had yet been released by Mn/DOT.

would be viewed as carrying more weight than either direct feedback from the general public or statements made by politicians and Mn/DOT officials. As such, they would like an unbiased analysis from a third party to provide them with information, such as:

- Travel times by time of day;
- Accident occurrences before and during the experiment; and
- Surveys of travelers to assess their opinions about the shutdown.

The findings from this initial qualitative process suggested the following actions:

- Develop programs (media and outreach) that can be used to educate the general public about the benefits and rationale of ramp metering;
- Post average waiting times on an electronic display located well before the entrance to a ramp to allow travelers to make decisions about using alternate routes; and
- Provide a degree of consistency between waiting times for adjacent ramp meters where wait times are adjusted for the amount of actual congestion on a roadway.

6.3.1.2 "Without Ramp Meters" Focus Groups

A discussion topic guide similar to the "with ramp meters" focus group was developed and included, the following general topics for discussion:

- General reactions toward the ramp meter shutdown;
- Impact of ramp meter shutdown on travel behavior;
- Media coverage of ramp meter shutdown;
- Evaluation of ramp meter shutdown experiment; and
- Preferences for alternative ramp meter solutions.

General Reactions Toward the Ramp Meter Shutdown

Given the negative attitudes of travelers toward ramp meters evidenced in the "with ramp meters" focus group, it was not surprising that reactions were quite positive about the shutdown experiment. Overall, participants' experiences traveling on freeways in the Twin Cities region were favorable since most felt that their commutes were now faster than before, and travel on the region's freeways did not appear to be any less safe than before. Further, once on the freeways, they did not experience any more back-ups than was typically the case before the shutdown. However, when probed, they did tend to concede that the freeways had become more congested. Overall, this situation was very surprising to some of the travelers who believed that there would be severe problems traveling in the region after the shutdown occurred.

In terms of their experiences on the ramps themselves, travelers' levels of frustration had completely vanished. Wait times at even moderately congested ramps disappeared and became a non-issue. Several travelers went on to mention that, instead of using alternate routes and back roads just to avoid the meters, they were now more likely to use a direct route, which meant using a once congested ramp to get onto the freeway. Thus, short trips, which were previously diverted away from freeways by ramp meters, were now re-attracted to the freeways.

Similar to what was heard in the "with ramp meters" groups, travelers would rather be moving, albeit even at slower speeds, than enduring long waits at meters. Also, some travelers appeared not to mind the perceived increase in congestion on the freeway, since being in "control" and having the "freedom" to make decisions about which routes to use made the situation tolerable. For example, if they found a freeway to be too congested, they could exit at the next ramp. In contrast, if they entered a ramp with a long queue, they were stuck. Thus, travel on the freeways was viewed as being even more predictable, since they did not have to anticipate the length of the wait at meters. Finally, merging into the freeway was brought up as something that needed to be improved. It was noted that many drivers in the region had been accustomed to a "managed" form of merging controlled by the meters and did not know how to aggressively merge in an "unmanaged" situation.

Impact of Ramp Meter Shutdowns on Travel Behaviors

Consistent with the "with ramp meters" focus group, very few travelers mentioned that they had actually modified their travel behavior or route taken to get to a particular destination. Except for a few travelers who were now more willing to use the freeways instead of taking alternate routes, they continued to use the same ramp entrances and routes as before.

Travelers were pleased that no new bottlenecks were created aside from the ones that existed before the experiment, which everyone in both traveler groups already knew about. Therefore, it appeared that their tolerance levels for such congestion even at bottlenecks had risen dramatically, since the single most common source of their frustrations (ramp meters) had been removed.

However, even though wait times and back-ups at ramps were substantially reduced or eliminated altogether, there was still a feeling that it would be necessary for some ramp meters to remain operational. This sentiment was based on the awareness that certain areas of the freeway system are still heavily congested and in need of metering to help alleviate such congestion. Therefore, in these cases, metering made sense.

Media Coverage of Ramp Meter Shutdowns

Travelers' expectations about what would happen after ramp meters were shutdown did not materialize. The expectation was that travel in the area would be difficult during the initial period of the experiment, and then taper off gradually to where it would become tolerable again. Consistent with this observation, travelers were very vocal about the way various media sources depicted the shutdown experiment both before and during its occurrence. In their view, the media made a big deal over nothing and tended to exaggerate the situation, making it more newsworthy than it should have been. Therefore, travelers tended to discount these stories and placed more importance on what they saw rather than what they heard.

All travelers mentioned that they were given sufficient information in a timely manner by Mn/DOT. When asked about the lead time given for when the shutdown actually would occur, travelers indicated that they knew about it anywhere from three to four weeks in advance. (In reality, Mn/DOT provided one week notification of the exact date of the shutdown.) Also, the various dissemination sources (television, radio, and newspapers) used were more than adequate in making sure the general public knew of the specific details of the shutdown.

Evaluation of Ramp Meter Shutdown Experiment

Similar to the "with ramp meters" focus groups, participants were very clear about the types of information they would like to have available from Mn/DOT to be able to judge the impact of the shutdown experiment. Again, information pertaining to traditional traffic performance measures would be viewed as carrying more weight than either direct feedback from the general public or statements made by politicians and Mn/DOT officials. As such, they would like to have traffic performance data, such as:

- Travel time by time of day; and
- Accident occurrences before and during the experiment.

However, unlike the previous sessions, they had very mixed feeling about what sources should be used to make these evaluations, and who should be responsible for sharing the outcome. Some participants thought that the funds could be better spent improving the freeway system in the region than in hiring an outside consultant to conduct the evaluation. However, many others were not as skeptical suggesting that an unbiased source should perform the evaluation.

Also, when it came to informing the public about the outcome of the shutdown experiment, participants in the "without ramp meters groups" were unanimous in their feelings that the information should come directly from Mn/DOT officials. Specifically, they mentioned that the best way to inform the public about the outcome and the future status of the experiment would be through a series of short announcements conducted with the media (primarily television and newspapers). They wanted to be able to hear the criteria that MN/DOT would be using to make its decisions about the status of metering, so that they could form their own opinions about the reliability and credibility of such performance measures.

Preferences for Alternative Ramp Meter Solutions

Prior to asking travelers what they would like to see done to improve ramp metering in the Twin Cities region, a vote was taken where they had to choose between three different outcomes based on their experiences with the recent shutdowns. The options included:

1. Re-open the ramp meters the way they were before,
2. Keep the ramp meters permanently closed, or
3. Keep ramp meters but change the way they operate.

Interestingly, no one chose to operate the meters the way they were before. However, travelers were equally split between shutting meters off and modifying their operation. Although they would like to have a source of frustration disappear, they believed that ramp metering does help to alleviate traffic congestion for certain areas of the region's freeway system. Travelers believed that Mn/DOT should try as many solutions as possible to improve traffic flow on the freeways.

In keeping with this attitude, travelers were given a series of potential ramp meter solutions to evaluate, which included:

- Keeping some meters open and others closed based on the degree of freeway congestion,
- Adjusting wait times at meters so that queues are shorter,
- Installing "smart" meters that adjust wait times to actual traffic congestion and queue lengths,
- Providing signage/displays at ramp meter entrances that post average wait times, and
- Shortening the hours of ramp metering during peak morning/afternoon travel.

Across both groups, travelers were very much in favor of either keeping some meters open and closing others, or installing "smart" meters to adjust waiting times to reflect a variety of traffic conditions. These two solutions were cited most often, followed by two others that included displaying wait times at ramp meter entrances and shortening the hours of ramp meter operations (especially turning them off earlier at night rather than turning them off later in the morning). Again, these solutions were in keeping with many of the opinions discussed during the sessions and provided acceptable courses of actions for Mn/DOT to take, if the decision is made to continue the experiment.

The "without ramp meters" group sessions suggest that the public wishes to have Mn/DOT continue to evaluate acceptable ramp metering solutions rather than merely turning them back on or keeping them permanently off. Specifically, these recommendations reflect the need to make changes in both travelers' driving behaviors and habits, and the actual operations of the ramp meters themselves as follows:

- Develop driver education programs that can be used to "train" travelers about appropriate ramp merging behaviors and freeway etiquette;
- Monitor ramp meters one at a time to evaluate whether it should be opened or permanently closed based on traffic conditions and the alleviation of congestion; and
- Install "smart" meters on those ramps that have been found to require metering, so that wait times reflect actual traffic conditions on the ramp at the time.

6.3.2 Statistical Analysis Methods

The objective of the statistical analysis was to quantifiably identify, measure, and interpret the impact of the ramp meter shutdown on travelers' behavior and their attitudes. To accomplish that, the statistical analysis focused on the sources of variation in the data to identify those statistically significant differences that could explain variations in the data by corridor, market segment, and whether the survey was taken before or after the experimental shutdown of the ramp meter system.

Another aim of the analysis was to present the results in a manner that was easy to communicate to the public about how ramp metering was perceived. Therefore, the statistical analysis and the presentation of the key findings encompasses a variety of methods that range from summary statistics, such as mean values of key variables, to tables and graphs that illustrate key differences, and to analysis of variance methods that identify statistically significant differences across survey waves and market segments.

- **Summary Statistics –** Means and distributions of key variables were used to build a snapshot picture of travelers' profile, travel behavior, and perceptions. The analysis included differences by corridor and market segment, as well as a comparative profile before and after the meter shutdown.

- **Tabulations and Graphs –** Groupings and tabulations of key variables, along with bar charts and pie graphs, highlight important differences in traveler profile, travel behavior, and attitudes by survey wave, corridor, and market segment in a manner that can be best communicated to the public.

- **T-Statistic Test –** Differences between mean values for a particular variable, such as travelers' attitudes before and after the shutdown, were assessed through the use of the t-statistic test. This test statistic takes into account the mean values for the variable under study, the variance of each variable, and the sample sizes. Statistically significant differences suggest that the observed change in attitudes is not a random variation, but can be attributed to the meter shutdown.

- **Chi-Square Test –** Differences between distributions of a particular variable are assessed by using the chi-square test. This test statistic is used to evaluate whether variables, such as socioeconomic characteristics with multiple categories (e.g., age and education), differ across corridors or between the two survey waves. Statistically significant differences indicate that there is a systematic difference that is not attributable solely to variation in the data.

- **Analysis of Variance (ANOVA) –** This statistical analysis method was used as an extension of the t-test approach. The objective of using this multivariate method is to identify whether there are statistically significant differences that can be explained by more than one factor simultaneously. An example is the identification of significant differences between the two waves of surveys, while controlling for differences due to the various market segments.

  The analysis of the random sample survey and the four corridor-specific surveys focused on "with ramp meters/without ramp meters" comparisons of travelers' travel behavior and attitudes toward travel in the Minneapolis/St. Paul metro area and toward ramp metering in particular. The statistical analysis identified important differences that are statistically significant at a 95-percent confidence level. To enhance the validity of these "with ramp meters/without ramp meters" comparisons the analysis also takes into account other factors that may have an impact on travelers' attitudes, such as:

- Their frequency of travel during a typical week;
- Socioeconomic characteristics of respondents;
- Differences in respondents' travel patterns; and
- The differences across the four freeway corridors under study.

- **Geographic Information Systems (GIS) –** Finally, the analysis has also been supported by the spatial comparison capabilities offered by GIS. The use of GIS tools allowed us to geocode and map the origins and destinations, and O-D travel patterns of travelers in the study area to ensure that:
  - They properly represented each corridor under study;
  - They collectively provided a representative sample of metro area travelers; and
  - There were no significant differences between the two survey waves ensuring the similarity and comparability of the two samples.

6.3.3 Steps in the Survey Analysis

The questions that have been addressed in the analysis include the following:

- What is the socioeconomic profile of travelers in the random and the corridor samples and how do these characteristics differ by corridor? Are there any important differences in the socioeconomic characteristics of respondents in the "with ramp meters" and "without ramp meters" survey samples that require them to be treated as different? (Section 6.4)

- What are respondents' overall travel patterns, what is travelers' experience with ramp metering, and how do travel patterns and experience with metering differ by survey type and by corridor? (Section 6.5)

- What has been the impact of the ramp metering shutdown on travelers' everyday travel patterns? How do travelers view the changes in travel time and traffic conditions that have resulted from the shutdown? (Section 6.5)

- What is travelers' experience with ramp wait times, how does that experience differ by corridor, and what is travelers' maximum willingness to wait at a ramp meter? (Section 6.6)

- What are travelers' attitudes toward their everyday commute and in particular, how do travelers view the features of the ramp metering system and its impact on their everyday travel? (Section 6.7)

- Has the shutdown affected the way travelers view the usefulness of the ramp meters? Are changes in traveler attitudes consistent across corridors and do they agree with changes reflected in the traffic and travel time data? (Section 6.8)

- Are there any important differences by market segment and by corridor that suggest that different types of commuters have different reactions to the ramp meter shutdown that need to be taken into account? (Section 6.8)

- Would travelers like to maintain the metering system, introduce changes to it, or shut if off after their experience with the experimental shutdown? What types of changes would they like to see introduced? (Section 6.10)

6.4 Socioeconomic Characteristics

The socioeconomic characteristics of each respondent were collected to develop a user profile across the different types of surveys and survey waves, and to control for potential differences by corridor that could affect the way respondents perceive the features of the ramp metering system. The information that was collected to build respondents' socio-economic profile included respondents' gender, age, education level, household size, car ownership, and household income. A detailed listing of the distribution of each socioeconomic variable by survey wave, type of survey, and by individual corridor is shown in Appendix E.

Traveler Profile – The socioeconomic profile of the typical commuter in the Minneapolis/ St. Paul area is provided by the random sample survey in each wave of the analysis (Table 6.1). Overall, respondents in the random sample have a high level of education and almost 70 percent of them are employed full time. Car ownership and incomes are also relatively high with more than 30 percent of the households in the random sample owning three or more cars, and with almost 30 percent of households having annual incomes of $80,000 or more.

The contrast between the corridor sample as a whole and the random sample exhibited some interesting differences in each of these socioeconomic characteristics. Corridor users were more likely to be college graduates, to own three or more cars, and to be employed full time compared to respondents in the random sample. Furthermore, corridor users were also found to be more likely to live in larger households and to have an average income that was higher than the income of respondents in the random sample.

Differences by Corridor – The contrast among the four corridor-specific samples showed some interesting socioeconomic differences that are summarized in Table 6.1. Commuters on the I-494 corridor were much more likely to be employed full time, to live in larger households, and to have a higher average income than commuters in other corridors. Corridor I-94 respondents had a higher education level, a much lower level of car ownership, and a high income that was comparable to I-494 users. In general, commuters on the I-35E and I-35W corridors either fell in the middle of the range defined by the I-94 and

I-494 corridor users, or were more closely comparable to the characteristics of the random sample respondents.

Table 6.1 Overview of Socioeconomic Characteristics in the "With Ramp Meters" Survey

	I-494	I-35E	I-35W	I-94	Random
College/post-graduate	52%	46%	42%	71%	48%
Three or more cars	38%	35%	36%	26%	31%
Full-time employment	88%	72%	76%	72%	68%
Three or more HH members	67%	62%	55%	54%	47%
Income > $80,000	39%	22%	26%	40%	27%

"With Ramp Meters/Without Ramp Meters" Comparisons – A total of 30 "with ramp meters/without ramp meters" comparisons for the socioeconomic characteristics were made taking into account the distributions of each of the six socioeconomic attributes across the four corridors and the random sample. As shown in Figures 6.1 and 6.2, the education and age characteristics of respondents in the sample track very closely in the "with ramp meters" and "without ramp meters" surveys. Out of the total of 30 comparisons, only two proved to be statistically significant at the 95-percent confidence level using the chi-square test, suggesting some differences in the income distributions of I-35E commuters and the random sample respondents in the "with ramp meters" and "without ramp meters" samples.

The detailed comparisons for each socioeconomic characteristic for each type of survey and the before and after survey waves are provided in Appendix E. Across the random sample surveys and across each corridor sample there is a similarity between the "with ramp meters" and "without ramp meters" survey samples illustrated in Tables E.1 through E.6 of the Appendix E. These 30 comparisons taken together support the high degree of similarity between the "with ramp meters" and "without ramp meters" sub-populations sampled in each of the four corridors and in the random sample. Therefore, differences in the responses of the "with ramp meters" and "without ramp meters" survey samples noted in the sections below are unlikely to be due to differences in the composition of the sample populations themselves.

Figure 6.1 Educational Profile of Respondents

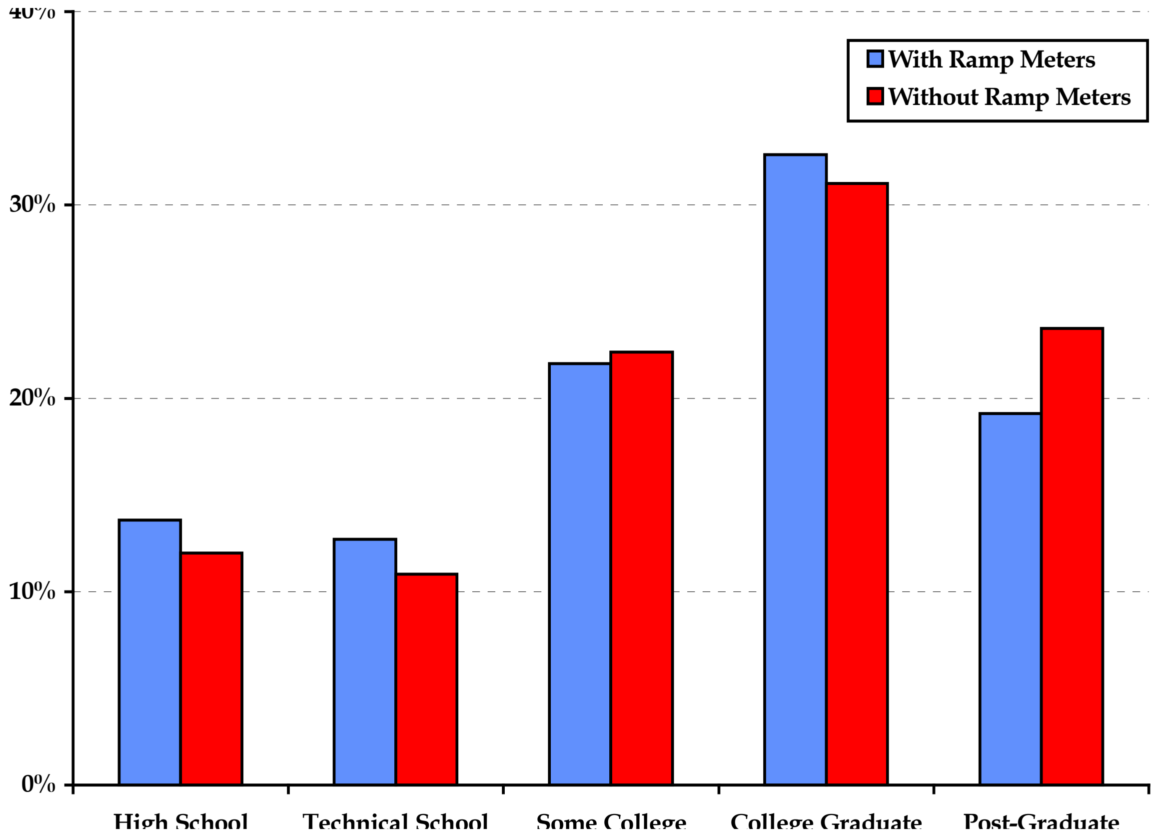
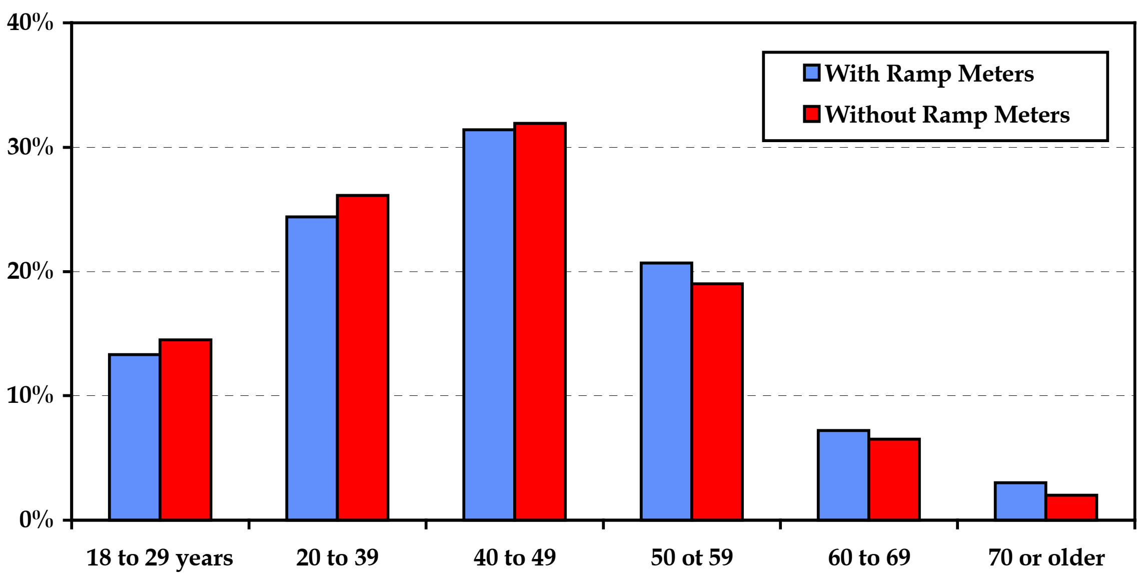


Figure 6.2 Age Profile of Respondents



6.5 Travel Patterns

6.5.1 Overall Travel Profile

As part of the survey, travelers framed their experience with ramp metering within the characteristics of their everyday travel. Respondents were asked to provide their origin, and destination, their estimates of total origin-destination travel times, and their estimates of time spent traveling on the freeway. Although these measures are not expected to be as accurate as the detailed travel time runs collected in each corridor, they provide benchmarks used by commuters in evaluating their travel experience across the corridors for both the before and after the shutdown conditions.

Geographic Distribution: A comparison of the geographic distribution of respondents' origins, destinations, and O-D travel patterns was made to ensure that there was an adequate dispersion of origins and destinations in the study area and to check the consistency of this pattern between the "with ramp meters" and "without ramp meters" survey samples. This comparison was made possible by the geocoding of the respondents' detailed origin and destination information provided in the survey. A detailed technical discussion of the methodology and software used in the geocoding process is provided in Appendix F.

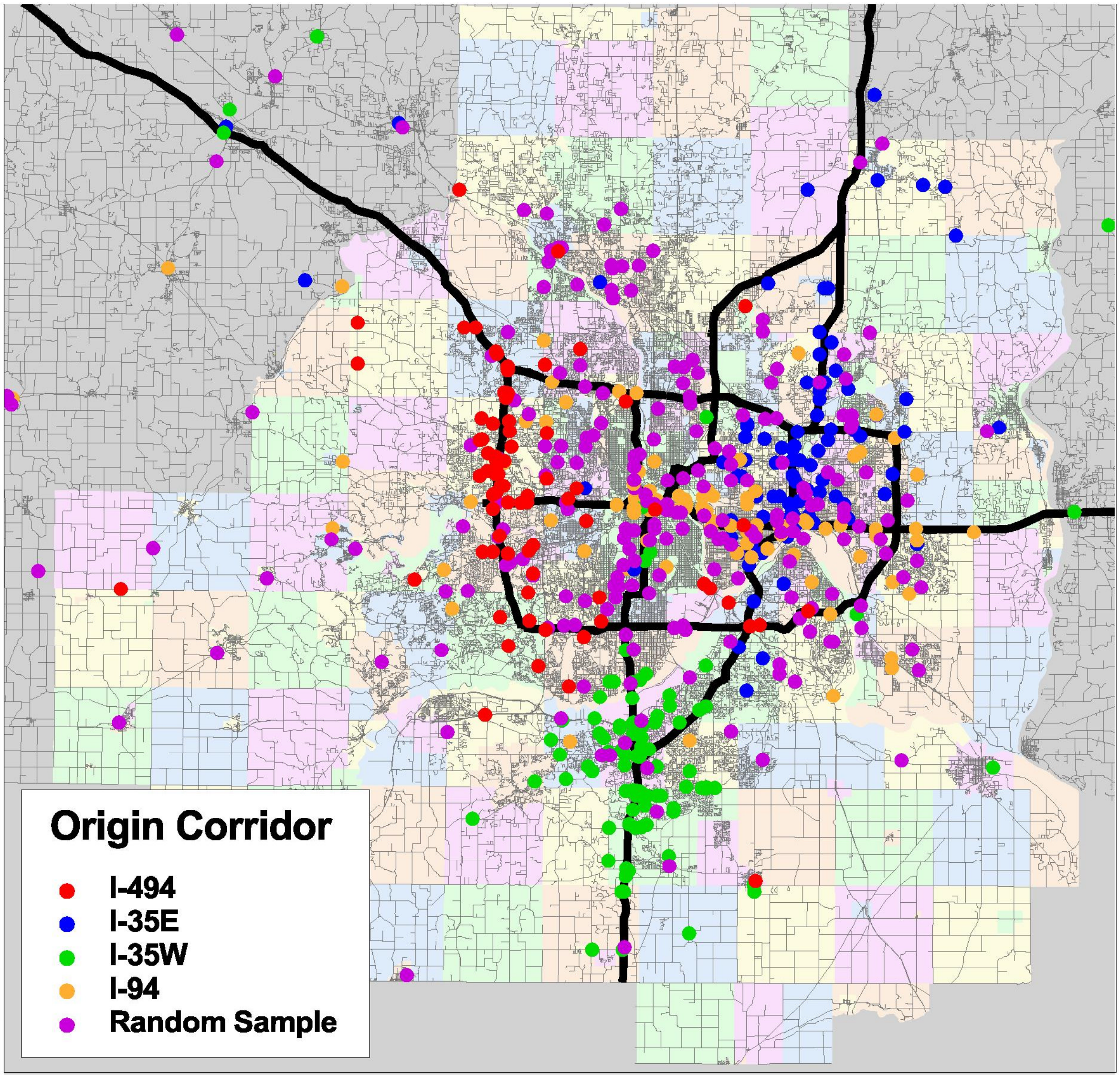
A comparison of travelers' origins in the "with ramp meters" and "without ramp meters" surveys is illustrated in Figures 6.3 and 6.4. These distributions suggest the dispersions of origins throughout the study area, as well as the great degree of similarity in the origins of respondents in both survey waves. The distributions of the origin-destination pairs shown in Figure 6.5 further underlines the widespread distribution of travel patterns in the area in the "without ramp meters" survey, a pattern that was again very similar to the distribution of O-D pairs in the "with ramp meters" survey.

Total and Freeway Travel Times – Respondents in the "with ramp meters" random sample reported an average total travel time of 28 minutes compared to an average of 34 minutes reported by corridor users. Freeway travel times were also lower among random sample respondents, an average of 20 minutes, compared to an average time of 24 minutes spent on the freeway by corridor users.

As shown in Figure 6.6, the distribution of travel times in the random survey was concentrated in the low end of the range with trips up to 25 minutes, while the travel times in the corridor sample were concentrated and evenly distributed between 20 minutes and one hour. The distributions of freeway travel times were comparable in the random and corridor samples with the exception of the predominance of short trips lasting less than 15 minutes in the random sample (Figure 6.7). The random sample undoubtedly captured more travelers making short local trips, while the corridor travelers tended to be making longer commuter types of trips.

The travel times by corridor highlight the similarities across the I-35E, I-35W, and I-94 corridors with "with ramp meters" freeway travel times of roughly 21 minutes, compared to the I-494 users who spent 50 percent longer on the freeway for an average of 32 minutes.

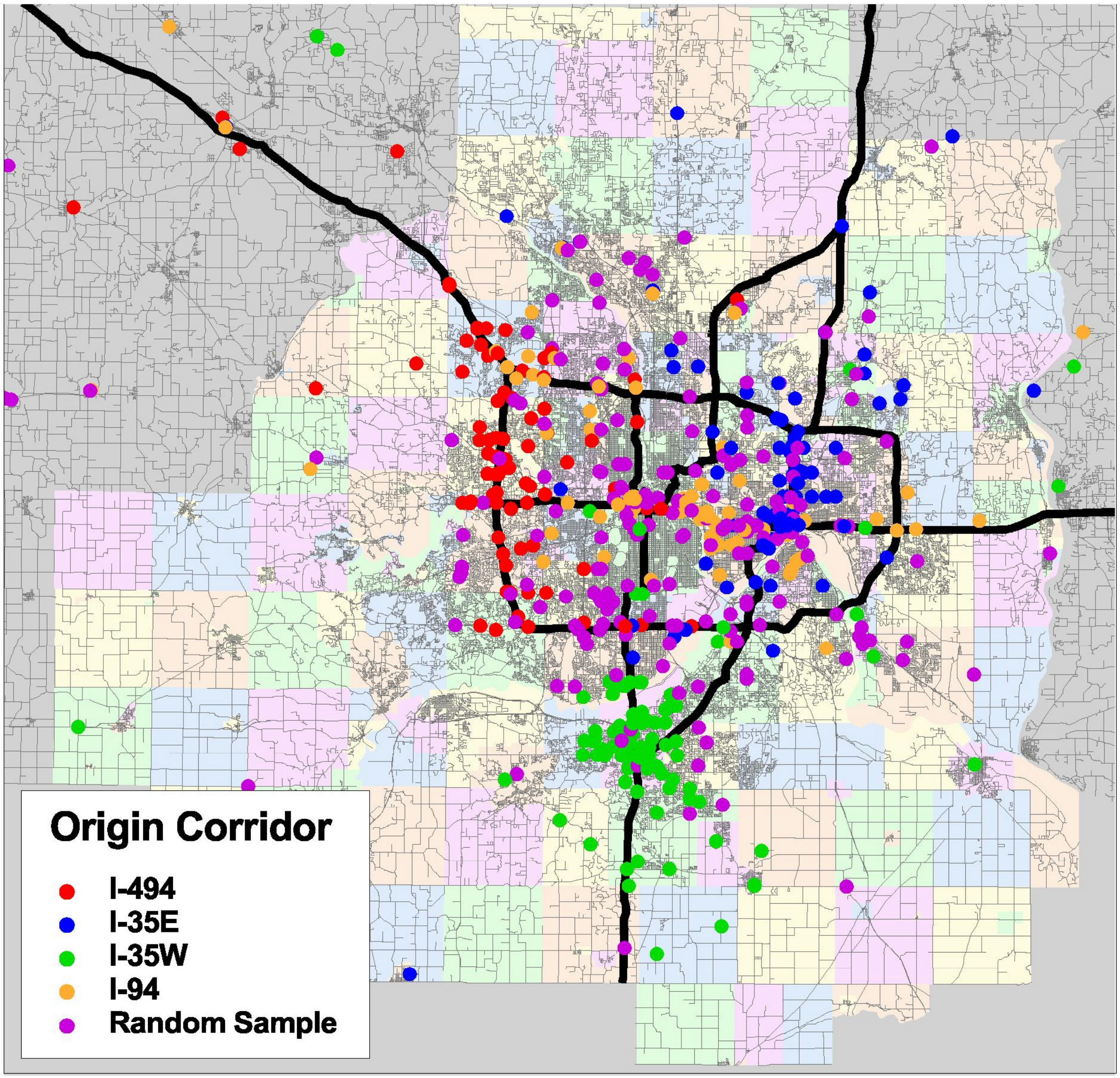
Figure 6.3 Origins of Travelers – "With Ramp Meters" Surveys



The same pattern holds for the total O-D travel times with I-494 users spending a total of 45 minutes on the road, 50 percent more than the 30-minute total travel time experienced by users of the other three corridors (Table 6.2). This difference between the I-494 corridor sample and the other corridor samples is important in explaining attitudinal differences described in the following sections.

"With Ramp Meters" and "Without Ramp Meters" Comparisons – A comparison of the "with ramp meters" and "without ramp meters" total travel times and freeway travel times (both for the random and for the corridor-specific samples) indicate an interesting and consistent pattern of travel time differences.

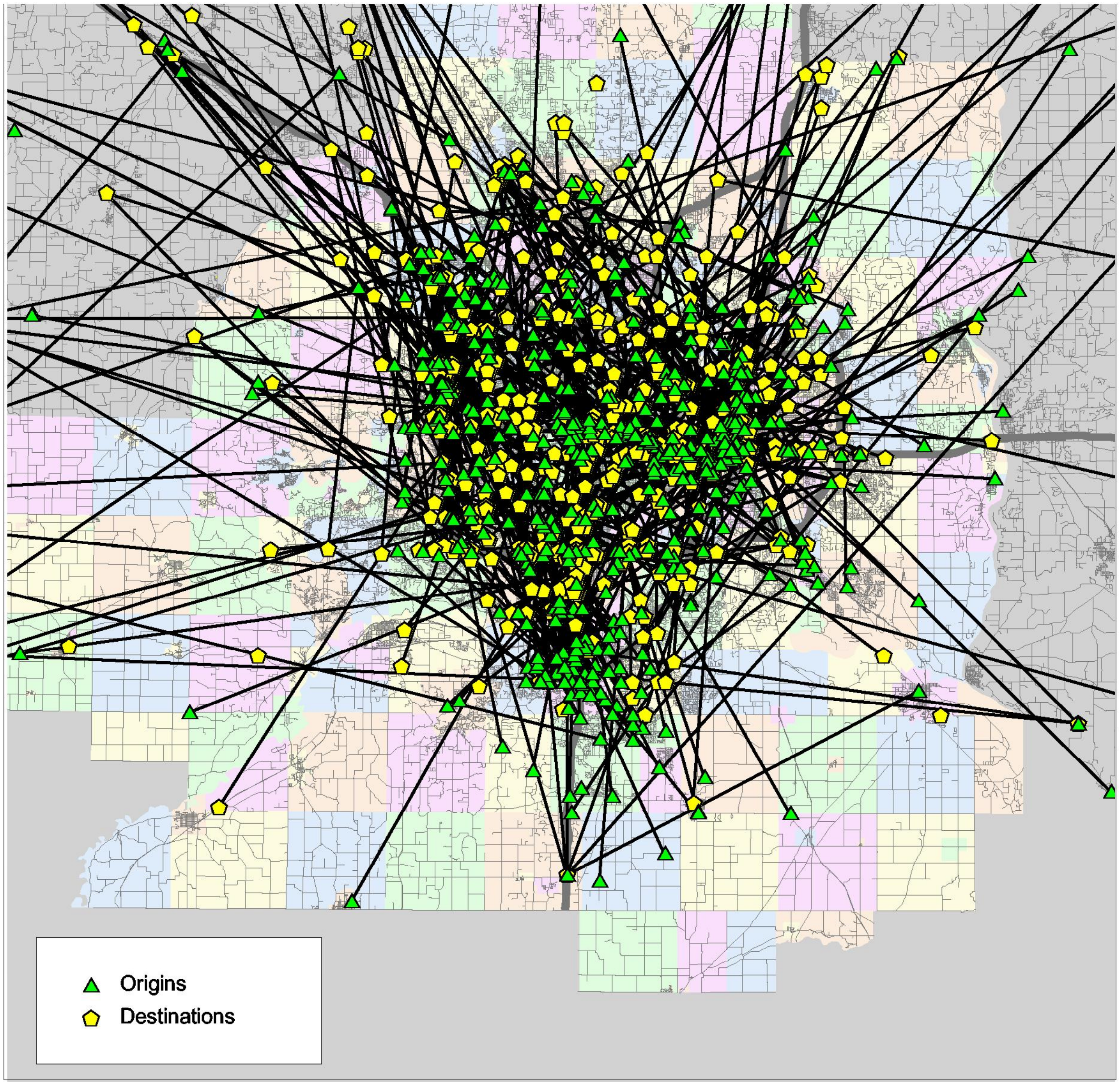
Figure 6.4 Origins of Travelers – "Without Ramp Meters" Surveys



Although some of the differences may be attributable to the slightly different mix of "with ramp meters" and "without ramp meters" origin-destination travel patterns within each corridor, there is a consistent pattern of increasing travel times shown in Table 6.2. Both the total travel times and freeway travel times have increased following the shutdown, a pattern that is consistent both in the random sample and in each of the four corridor samples.

The difference in the total travel time ranges from only a marginal increase in the random sample to a six- and eight-percent increases, respectively, in the I-35W and I-94 corridors, to a high of a 15-percent increase in travel time in the I-35E corridor. There is a similarly consistent pattern of increases in the time spent traveling on the freeway. Increases in

Figure 6.5 Origin-Destination Patterns – "Without Ramp Meters" Surveys



freeway time range from a low of 2.5 percent for the I-35W corridor, to a 17 percent increase for the I-94 corridor, and to a high of 35 percent in freeway travel time in the I-35E corridor sample.

Comparison with Travel Time Data – This empirical analysis is consistent with the travel time findings summarized in Section 5.2. According to the travel time comparisons, the percentage change in travel time in the I-35E southbound a.m. corridor was 40 percent, one of the highest increases among the studied corridors. This suggests that I-35E travelers' reported travel times properly reflect the changes in travel times.

Figure 6.6 Origin-Destination Total Travel Times – "With Ramp Meters" Surveys

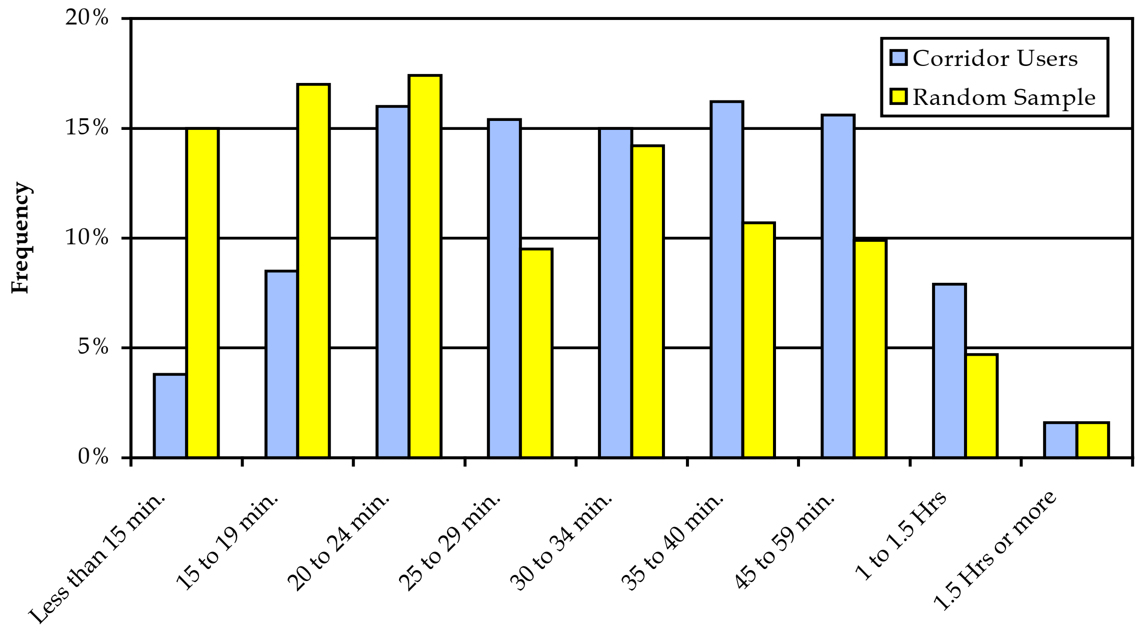


Figure 6.7 Freeway Travel Times – "With Ramp Meters" Surveys

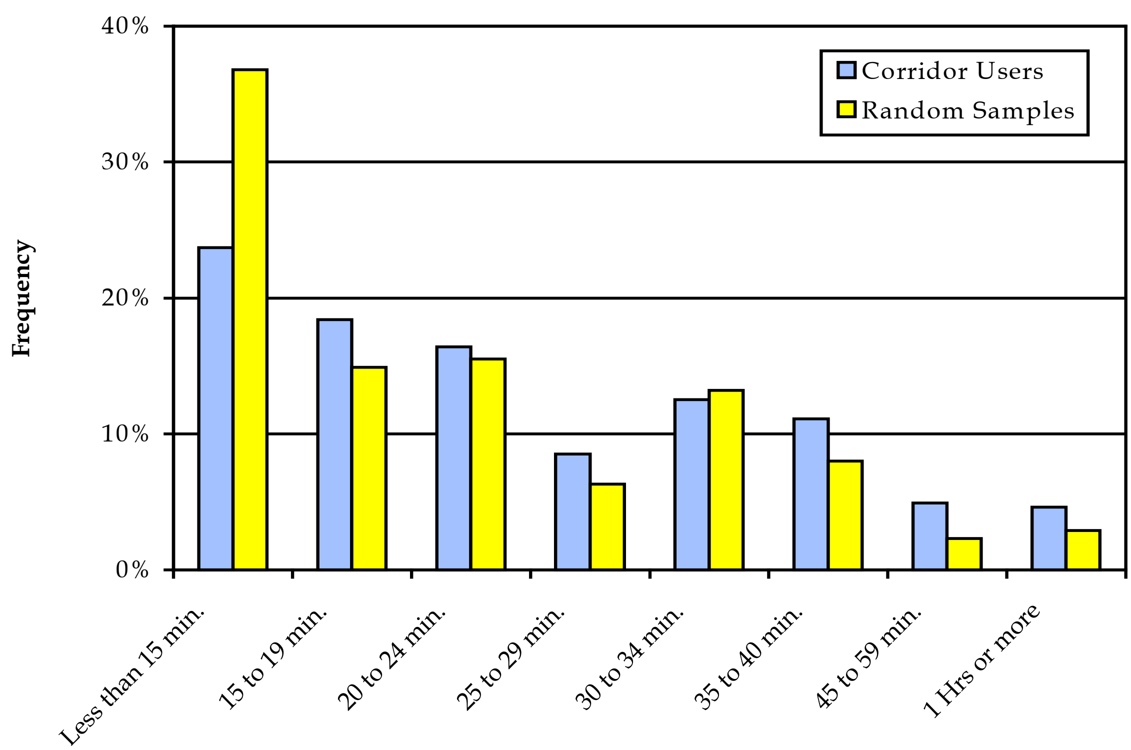


Table 6.2 Total and Freeway Travel Times Reported in the Surveys

	Total Travel Time (minutes)			Freeway Travel Time (minutes)		
	With Ramp Meters Survey	Without Ramp Meters Survey	Percentage Change	With Ramp Meters Survey	Without Ramp Meters Survey	Percentage Change
Random Sample Survey	28.0	28.1	0.4%	20.4	22.4	9.8%
I-494 Corridor Survey	45.4	46.2	1.8%	31.9	34.3	7.5%
I-35E Corridor Survey	30.7	35.5	15.6%	21.5	29.2	35.8%
I-35W Corridor Survey	31.1	33.1	6.4%	21.9	22.5	2.7%
I-94 Corridor Survey	29.9	32.2	7.7%	21.3	24.9	16.9%

6.5.2 Time-of-Day and Route Diversion Patterns

One of the questions that was of interest to the ramp metering analysis was the extent to which travelers would divert to different routes, use different ramps to enter the freeway, or shift to another time of day to avoid congestion as soon as the ramp meter system was turned off. These likely diversion patterns were addressed both in the "with ramp meters" and in the "without ramp meters" surveys and are summarized in this section.

"With Ramp Meters" Diversion Patterns – In the "with ramp meters" survey, respondents were asked whether they were familiar with alternate routes to their destination and with different entrance ramps to the freeway system. Combined with a question on whether travelers were likely to shift to an earlier or later departure time to avoid congestion on the freeway, these questions served as general indicators of travelers' propensity to divert to different routes and times of day.

The analysis of the "with ramp meters" random and corridor surveys indicates that travelers in the Minneapolis/St. Paul area are generally familiar with both route and time-of-day diversions (Table 6.3). Travelers are more likely to leave at a different time of day to avoid congestion and to use a different ramp entrance to avoid back-ups, rather than use a different route altogether. This pattern was similar for the random and the individual corridor samples with the users of the I-35W corridor being considerably more likely to shift their departure time to avoid congestion in the I-35W corridor.

"Without Ramp Meters" Diversion Patterns – In the "without ramp meters" survey, respondents who frequently used a particular freeway were asked whether following the ramp meter shutdown they experimented with different routes, and whether they left earlier or later to avoid traffic congestion. Roughly a quarter of the random survey respondents experimented with either route or time-of-day diversions. This percentage was larger in the corridor surveys where respondents were more likely to experiment with different options (Table 6.4).

Table 6.3 Diversion Patterns in the "With Ramp Meters" Surveys

	Random Sample	I-494 Corridor	I-35E Corridor	I-35W Corridor	I-94 Corridor
Route Diversion					
Sometimes use alternate routes to avoid waiting at ramp meters	68.8%	71.4%	72.0%	72.0%	71.0%
No	31.2%	28.6%	28.0%	28.0%	29.0%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Time-of-Day Diversion					
Sometimes leave earlier or later to avoid traffic congestion	78.7%	75.4%	78.4%	85.6%	74.8%
No	21.3%	24.6%	21.6%	14.4%	25.2%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Ramp Diversion					
Sometimes avoid a ramp that is backed up with traffic and use a different ramp to enter a freeway	75.1%	77.0%	76.0%	80.0%	79.4%
No	24.9%	23.0%	24.0%	20.0%	20.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 6.4 Diversion by Frequent Freeway Users in the "Without Ramp Meters" Surveys

	Random Sample	I-494 Corridor	I-35E Corridor	I-35W Corridor	I-94 Corridor
Route Diversion					
Tried other routes since the ramp meter shutdown	23.3%	45.3%	36.0%	35.7%	41.9%
Always used the same route since the ramp meter shutdown	76.7%	54.7%	64.0%	64.3%	58.1%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Time-of-Day Diversion					
Sometimes left earlier or later to avoid traffic congestion	25.6%	40.2%	33.9%	41.7%	33.1%
Did not leave earlier or later to avoid congestion	74.4%	59.8%	66.1%	58.3%	66.9%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

A comparison of the diversion patterns across corridors also shows some interesting corridor-specific patterns. Users of the I-494 corridor showed a greater degree of experimentation than users of the other corridors with 45 percent experimenting with alternate routes compared to a third among I-35E and I-35W commuters and 40 percent of I-94 users. Similarly, 40 percent of I-494 users and 42 percent of I-35W users tried a different time of day to avoid congestion compared to a third of commuters using the I-35E and I-94 corridors (Table 6.4). This willingness to experiment is consistent with the generally longer commutes experienced by the I-494 users.

6.5.3 Retrospective Evaluation of Traffic Conditions

As part of the "without ramp meters" survey, respondents were asked to evaluate any changes in the traffic conditions that they faced in their everyday commute as a result of the ramp meter shutdown. Two questions also addressed their experience with the total travel time and the time they spent on freeways during their everyday travel. Specifically, respondents were asked the following set of questions that were adjusted for the random sample and the corridor surveys and were also customized to each respondent's travel experience:

> *"You said that your last trip took ___ minutes to travel from ___ (your origin) to ___ (your destination). Was this time longer or shorter than when you made this same trip <u>before</u> the meters were turned off?"*

> *"You say that on your last trip you spent ___ minutes driving on <u>any</u> freeways. Was this time longer or shorter than when you made this same trip <u>before</u> the meters were turned off?"*

> *"Since the ramp meter shutdown, do you think traffic conditions on ___ freeway are better or worse than before the shutdown?"*

Tables 6.5 to 6.7 suggest a balanced response to all three questions among the sample random respondents. Travelers in the "without ramp meters" random sample were more or less equally split among those believing they were better off than before, worse off than before, and those who didn't perceive any big changes due to the shutdown.

In contrast, the analysis of the same three questions across the four corridors identified some revealing differences with I-494 users showing up as different than commuters in the other three corridors. More than half of the I-494 users responded that their trip took longer following the meter shut off with only a quarter of the respondents experiencing an improvement (Figure 6.8). The same pattern was true for the travel time spent on the freeways with only 18 percent of the I-494 corridor users considering their current commute an improvement in terms of travel time spent on the freeway.

Finally, an equally strong pattern was reflected in I-494 users' assessment of the overall traffic conditions. Sixty percent of the I-494 users believe that they are worse off with the meters shut down, compared to just 17 percent who see the meter shutdown as an improvements in traffic conditions (Figure 6.9). These responses are in agreement with

Table 6.5 Reported Changes in Total Travel Time: "Without Ramp Meters" Surveys ***(Freeway Users Who Made Same Trip Before Ramp Meter Shutdown)***

	Percentage				
	Random Sample	**I-494 Corridor**	**I-35E Corridor**	**I-35W Corridor**	**I-94 Corridor**
Recent trip was longer than before meters were turned off	25.8%	54.1%	33.1%	30.4%	33.9%
Recent trip was shorter than before meters were turned off	31.3%	26.2%	31.5%	42.4%	34.7%
Recent trip was about the same	43.0%	19.7%	35.5%	27.2%	31.5%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

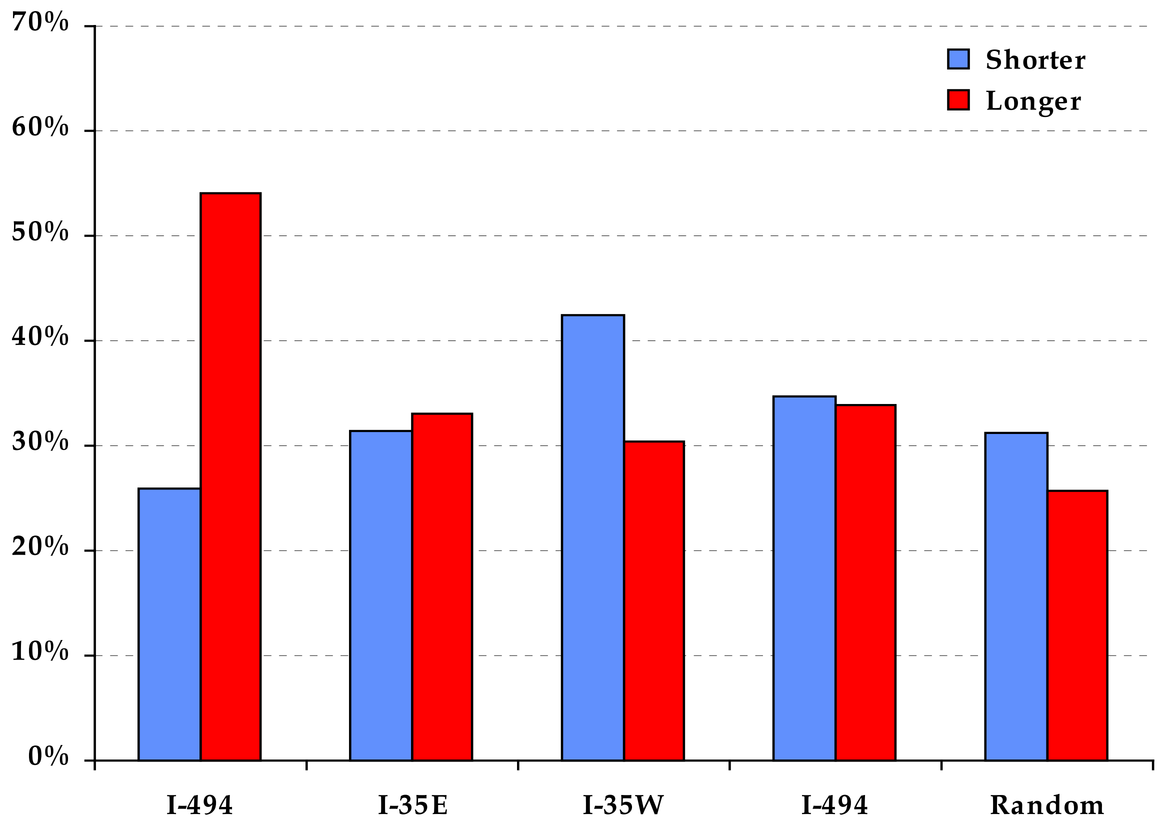
Table 6.6 Reported Changes in Freeway Travel Time: "Without Ramp Meters" Surveys ***(Freeway Users Who Made Same Trip Before Ramp Meter Shutdown)***

	Percentage				
	Random Sample	**I-494 Corridor**	**I-35E Corridor**	**I-35W Corridor**	**I-94 Corridor**
Freeway travel time was longer than before meters were turned off	30.7%	50.4%	33.6%	34.7%	39.5%
Freeway travel time was shorter than before meters were turned off	23.6%	18.2%	26.4%	20.2%	25.8%
Recent freeway travel time was about the same	45.7%	31.4%	40.0%	45.2%	34.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 6.7 Reported Changes in Traffic Conditions: "Without Ramp Meters" Surveys ***(Freeway Users Who Made Same Trip Before Ramp Meter Shutdown)***

	Percentage				
	Random Sample	**I-494 Corridor**	**I-35E Corridor**	**I-35W Corridor**	**I-94 Corridor**
Traffic conditions better now than before meters were turned off	29.9%	17.5%	30.3%	48.4%	52.1%
Traffic conditions worse now than before meters were turned off	33.1%	61.7%	36.9%	29.0%	22.3%
Traffic conditions are about the same	37.0%	20.8%	32.8%	22.6%	25.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Figure 6.8 Reported Changes in Travel Times After the Shutdown "Without Ramp Meters" Surveys

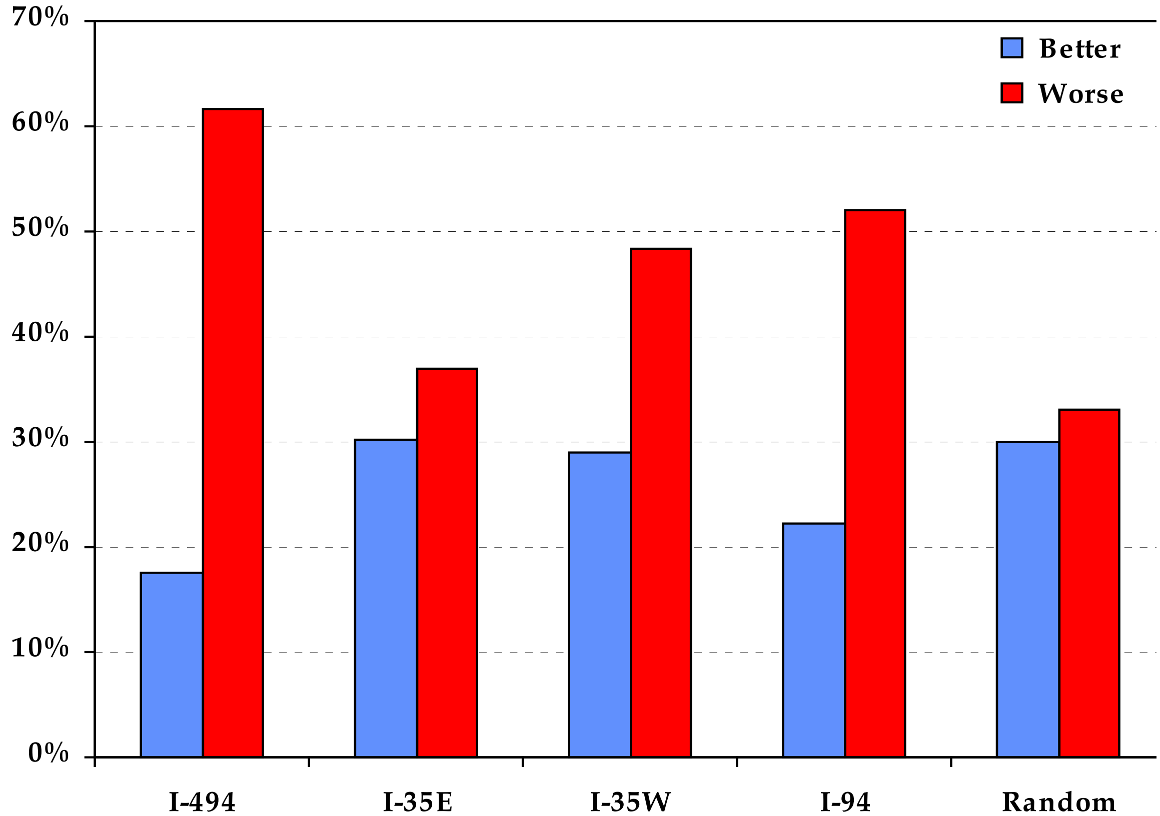


the traffic and travel time data discussed in Section 5.2 that showed decreases of 12 percent and 21 percent (northbound p.m. and southbound a.m., respectively) in the average speed in the I-494 corridor and an increase in the variability of I-494 freeway speeds. These responses also support the supposition that ramp metering is most beneficial to long distance commuters with origins in the outlying regions of the metro area, such as those surveyed in the I-494 corridor.

Unlike their I-494 counterparts, commuters on the I-35E and I-94 corridors were more ambivalent regarding the changes in their total and freeway travel times (Tables 6.5 and 6.6). Roughly one-third of I-35E and I-94 respondents believed that they were worse off, one-third believed that they were better off, and the other third believed that there was not much change since the shutdown. Although I-35W commuters were also in a three-way tie regarding their evaluation of the total O-D commute time, most of them thought that travel time on I-35W and the other freeways they use in their everyday travel had increased as a result of the shutdown.

Finally, the assessment of overall traffic conditions was again a little different than the evaluation of travel times (Table 6.7). Although respondents using the I-35E corridor were in a three-way tie, almost 50 percent of users on I-35W and on I-94 thought that they now faced worse overall traffic conditions as a result of the shutdown.

Figure 6.9 Reported Changes in Traffic Conditions After the Shutdown "Without Ramp Meters" Surveys



Comparisons with Travel Time and Speed Variability Data – These responses are in agreement with the traffic and travel time data discussed in Section 5.2 that showed a decrease of four percent in the average speed in the I-35W corridor. Meanwhile, I-94 eastbound p.m., I-94 westbound a.m., and I-94 westbound p.m. commuters experienced speed reductions of 11 percent, 15 percent, and 16 percent, respectively. In all cases, variability of speeds increases, especially on I-94.

6.6 Ramp Wait Times

Since one of the primary objectives of the market research study was to assess travelers' attitudes toward ramp metering, survey respondents were asked to estimate their typical ramp wait times. These wait times reported by individual travelers were analyzed to better understand the context which travelers face in their everyday commute, since ramp wait times affect their travel behavior and their attitudes toward ramp metering.

During the description of their typical commute trip, respondents were asked a battery of detailed questions related to the ramp they used to enter the freeway and their corresponding experience at the ramp meter. A series of questions was used to identify the following types of information for each traveler:

- The ramp entrance travelers used to enter the freeway, the time of day they entered the ramp, and the existence of an operating meter on each ramp;
- Vehicle occupancy to distinguish between travelers who avoided a ramp meter by car-pooling and using the by-pass lane, and those who had to wait at a meter;
- The number of ramp meters that each traveler encountered during his/her trip to reflect any additional wait times due to freeway-to-freeway ramp metering;
- The reported ramp meter wait time at each metered ramp encountered in their trip;
- Their experience with encountering longer ramp meter wait times than those encountered during their last typical trip; and
- Their maximum willingness to wait at a ramp beyond which they wish they had used an alternate route or ramp entrance.

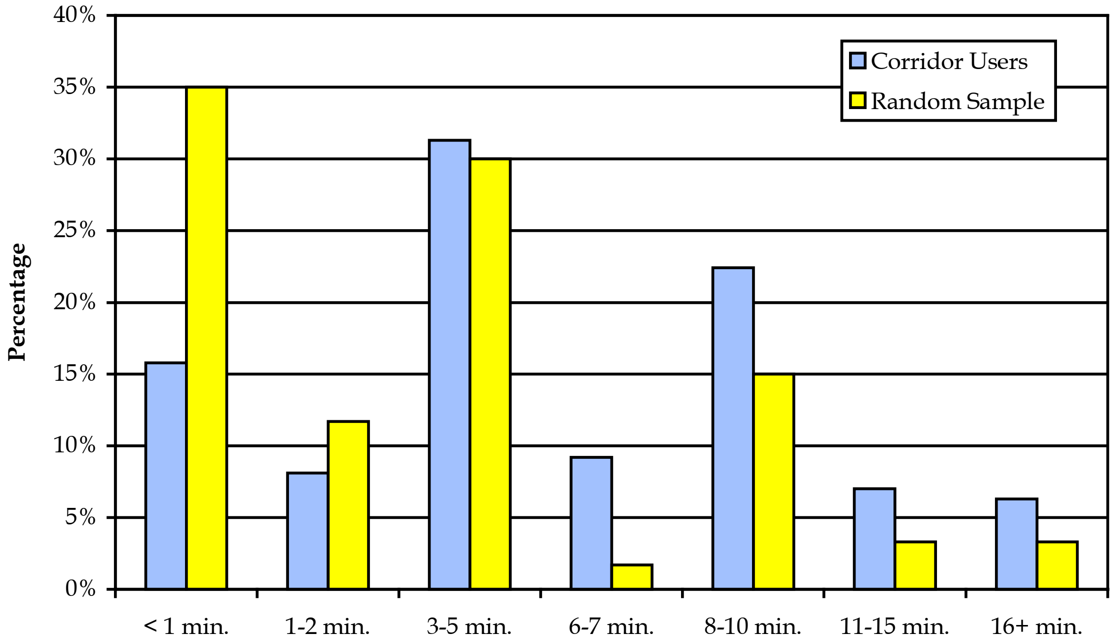
Affected Population – An analysis of the ramp usage patterns in the "with ramp meters" survey suggests the frequency with which travelers in the metro area need to wait at a ramp meter and provides an estimate of the population affected by ramp metering on a typical day.

In the "with ramp meters" random sample, a total of 61 respondents representing 24 percent of the sample had to wait at a ramp meter during their typical commute trips. In contrast, the targeted sample of "with ramp meters" corridor users shows that 208 respondents (40 percent of the sample) had to wait at a ramp meter. This difference underlines the much lower incidence of ramp meter waiting in the population as a whole, when compared to freeway corridor users.

Furthermore, the percentage of respondents who had to wait at two or more ramp meters during their commute was much lower. Only four percent of the random sample respondents and nine percent of the respondents in the "with ramp meters" corridor sample had to wait at two or more meters. Again, this pattern underscores the different experience of all travelers in the Minneapolis/St. Paul area as compared to the experience of freeway users.

Ramp Wait Times – The distribution of ramp wait times experienced by metered users and grouped together in two- to five-minute intervals is shown in Figure 6.10. This figure again distinguishes between travelers in the random and the corridor samples, and includes only those respondents who entered a freeway from an entrance controlled by an operating ramp meter. On average, respondents in the random sample reported that they waited an average of 4.5 minutes, while respondents across the four corridors reported an average wait time of 6.7 minutes.

Figure 6.10 Distribution of Ramp Wait Times Among Metered Users "With Ramp Meters" Corridor and Random Sample Surveys



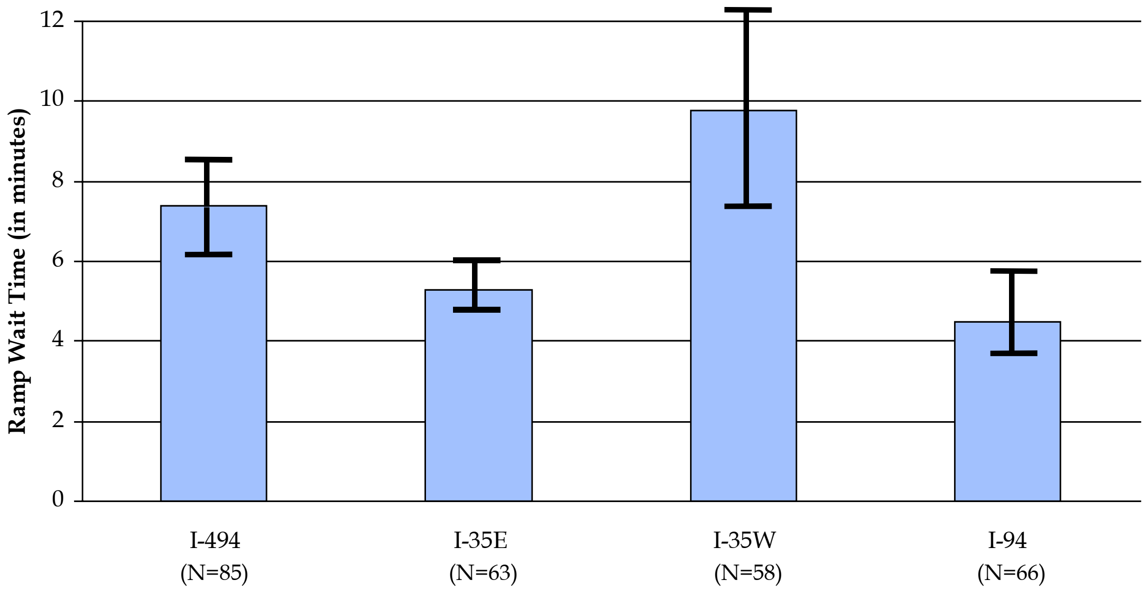
The most frequent wait time reported by the random sample respondents was less than one minute, with more than 75 percent of the wait times being five minutes or less. In contrast, only 15 percent of the corridor users reported wait times of one minute or less, and roughly 50 percent reported wait times of five minutes or less. This pattern further differentiates the two samples with the freeway corridor users more likely than the population at large to:

- Encounter a wait at the ramp meter, and
- Have to wait longer at the ramp meter.

Differences by Corridor – An analysis of the average ramp wait times across corridors shown in Figure 6.11 also illustrates some interesting differences across corridors. The average wait time reported by I-35W corridor users was the highest at 9.8 minutes with almost 30 percent of the respondents reporting ramp wait times of 11 minutes or longer. It should be noted also that I-35W users had the greatest variability in reported ramp wait times compared to the other three corridors, indicating either a wide range of perceived times or a great variation in ramp wait times by time of day.

The second highest average wait time was reported by I-494 users, who believed that on average they had to wait at a ramp for 7.4 minutes. The commuters on I-35E reported an average wait times just above five minutes while the lowest wait time was reported by I-94 users who thought that they waited at a ramp 4.5 minutes on average.

Figure 6.11 Average Ramp Wait Times Among Metered Users "With Ramp Meters" Corridor Surveys



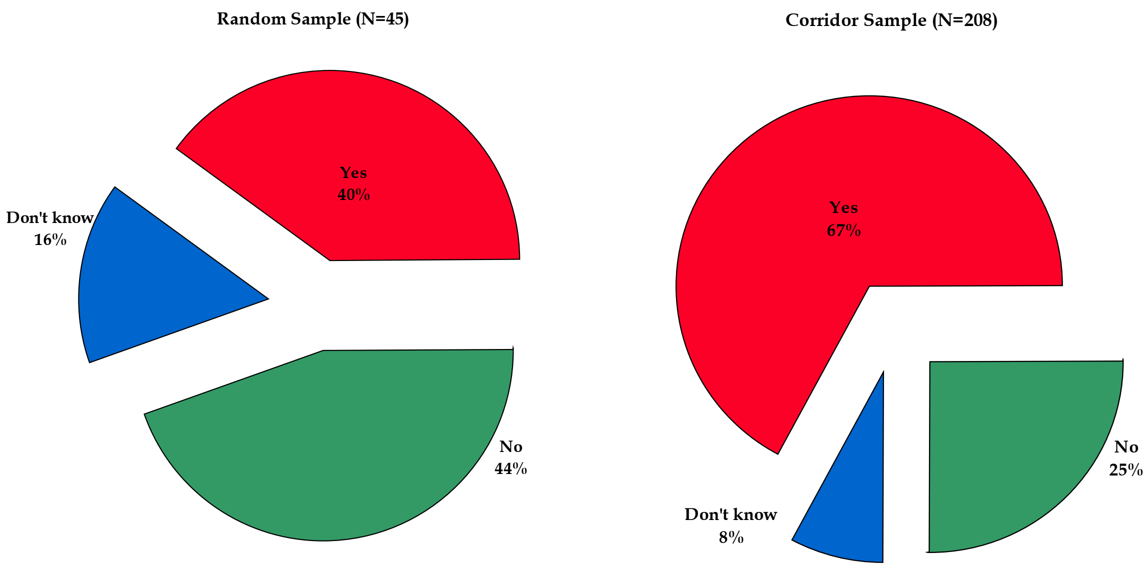
In comparison to the traffic data presented in Section 5, average perceived wait times are about equal to actual wait times for the peak hour only. In comparison to the total peak period, perceived wait times are about twice as high as actual wait times (roughly five to six minutes compared to two to three minutes). It is typical for travelers to perceive wait times of all kinds (waiting for a bus, etc.) to be about twice as long as reality. This highlights the importance of ramp wait time in travelers evaluation of their travel experience and the role of ramp meters.

Experience with Longer Wait Times – In addition to travelers' experience with their last typical trip, the survey examined the overall experience of travelers with ramp wait times. Travelers' experience with wait times longer than those reported for their last typical trip was obtained by asking respondents the following question:

> *"Considering all your trips when you use the freeway and wait at the ramp meters, do you find that any of your trips are 10 or 15 minutes longer because of longer wait times at the ramp meters?"*

The results summarized in Figure 6.12 suggest another important difference between the population at large included in the random sample as compared with the corridor-specific samples. In the random sample, 40 percent of respondents reported that they had experienced 10- to 15-minute additional delays due to ramp wait times. In contrast, two out of three respondents using the four corridors reported that, in their experience, they had suffered similar delays due to ramp metering.

Figure 6.12 Experience of Longer Ramp Wait Times



Maximum Willingness to Wait: Finally, respondents in both samples were asked about their tolerance for ramp wait times. The question was phrased as follows:

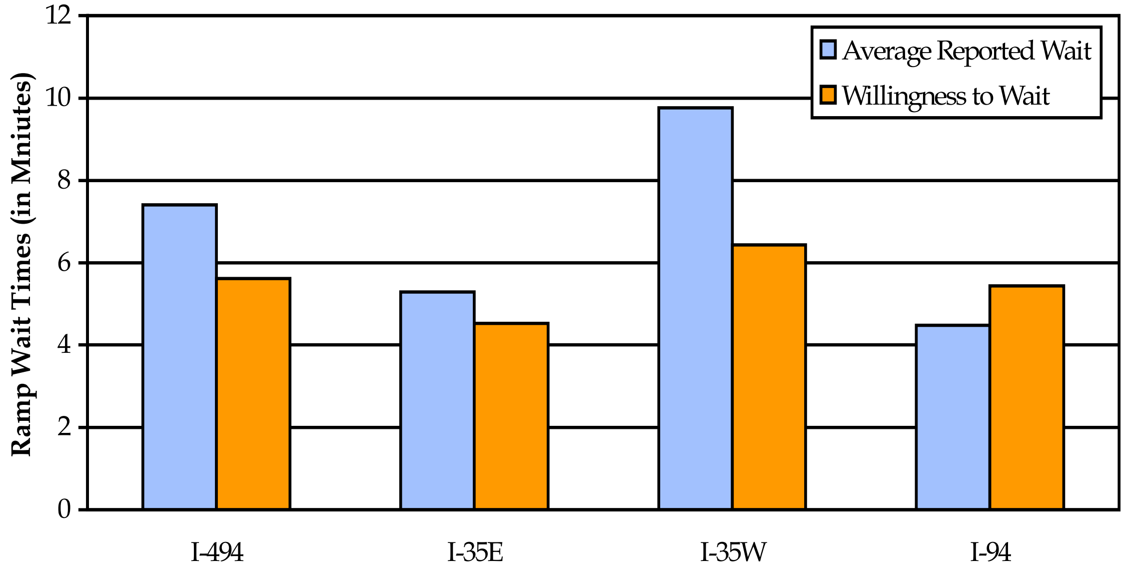
> *"How many minutes are you willing to wait at a ramp meter before you wish you had used a different route?"*

The responses to this question can be interpreted as a threshold beyond which respondents view ramp wait times as unreasonably long. The average maximum acceptable wait time was 5.0 minutes among random sample respondents, and somewhat higher for an average of 5.5 minutes among corridor users.

As shown in Figure 6.13, there were also differences in the stated maximum willingness to wait at a ramp meter among commuters in each of the four freeway corridors. These differences highlight a greater tolerance toward ramp meter wait times among I-35W corridor users, while commuters on I-35E appear to be the least tolerant of long ramp wait times.

Travelers' tolerance limits are consistent with the highest perceived wait times that were experienced by corridor for I-35W users and the lowest average perceived times experienced by I-35E users (Figure 6.13). Travelers are willing to wait at a ramp but clearly not beyond the reasonable bounds of their everyday travel experience. Furthermore, these findings are also consistent with the detailed estimates of ramp wait times by corridor reported in Section 5.0.

Figure 6.13 Maximum Willingness to Wait at a Ramp "With Ramp Meters" Corridor Surveys (N=507)



6.7 Attitudes Toward Ramp Metering

The patterns of travelers' ratings of highway level of service and ramp meters in the Minneapolis/St. Paul area generally reflect the qualitative insights gained from the focus groups. During the "with ramp meters" focus groups, participants' comments signaled a clear overall dislike of the concept of ramp meters. Participants expressed their frustration with the large number of ramps in the area, the long waiting times at the meters, the backups of the ramp queues onto the local streets, and the perceived lack of consistency between waiting times and level of freeway congestion.

These qualitative insights were translated into a set of questions that elicited travelers' attitudes toward their overall travel in the area, as well as specific attributes of their travel experience that are affected by ramp operations. Respondents rated the statements on a scale of one to 10, with a rating of one – meaning that respondents strongly disagreed with a statement, and a rating of 10 – suggesting that they strongly agreed. The wording of the attitudinal statements was intentionally mixed with both positively and negatively worded statements to control for any wording biases. The order of the statements was also randomized to avoid any ordering biases. Table 6.8 provides a detailed list of the attitudinal questions that respondents were asked as part of "with ramp meters" surveys.

Figures 6.14 and 6.15 show the average ratings for the attitudinal statements from the "with ramp meters" corridor survey. These graphs illustrate generally low ratings for ramp-related performance measures and somewhat higher ratings for overall network

Table 6.8 Attitudinal Statements for Freeway and Ramp Meter Performance

Now I would like you to think about your normal day-to-day travel throughout the Minneapolis-St. Paul metro area. I will read some statements that may or may not describe your travel experience. As I read each statement, please use a scale of one to 10 to tell me how much you agree with the statement. One means you disagree strongly and 10 means you agree strongly. The first statement is – **READ STATEMENTS, ONE AT A TIME**:

REPEAT AS NEEDED: One means you disagree strongly and 10 means you agree strongly.
ROTATE STATEMENTS A THROUGH D AND ROTATE F THROUGH S.
RECORD RESPONSE OF 1-10.

A. I feel safe from car crashes when driving on freeways.

B. A special lane on the freeway for buses and carpools is a waste of freeway space.

C. The Minneapolis-St. Paul metro area has a good freeway network to move traffic.

D. When I travel during peak traffic hours, my travel time is predictable so I can plan to arrive on time.

E. Overall I am satisfied with the ramp meter system.

F. The length of time that I wait at ramp meters is usually too long.

G. I never know how long I will have to wait at a ramp meter.

H. I feel safe when leaving a ramp meter and merging into freeway traffic.

I. Ramp meters improve the area's overall traffic flow.

J. The cost of ramp meters is a good value for taxpayers.

K. Ramp meters shorten my travel time overall.

L. Ramp meters reduce car crashes.

M The ramp by-pass lanes are of benefit to people like me.

N. Some meters may not be necessary since I never have to wait at those meters during the peak traffic hours.

O. Buses and car pools should have the advantage of using ramp by-pass lanes.

P. Sometimes I need to wait at a ramp meter for a long time even when the highway traffic seems to be moving well.

Q. I wish there were more alternate routes that I could use to avoid ramp meters.

R. Ramp meters often cause congestion on local streets when the wait lines extend for one or more city blocks.

S. There should be an electronic sign before each ramp, telling the wait time at the ramp meter.

Figure 6.14 General Attitudes Toward Travel
"With Ramp Meters" Corridor Surveys (N=500)

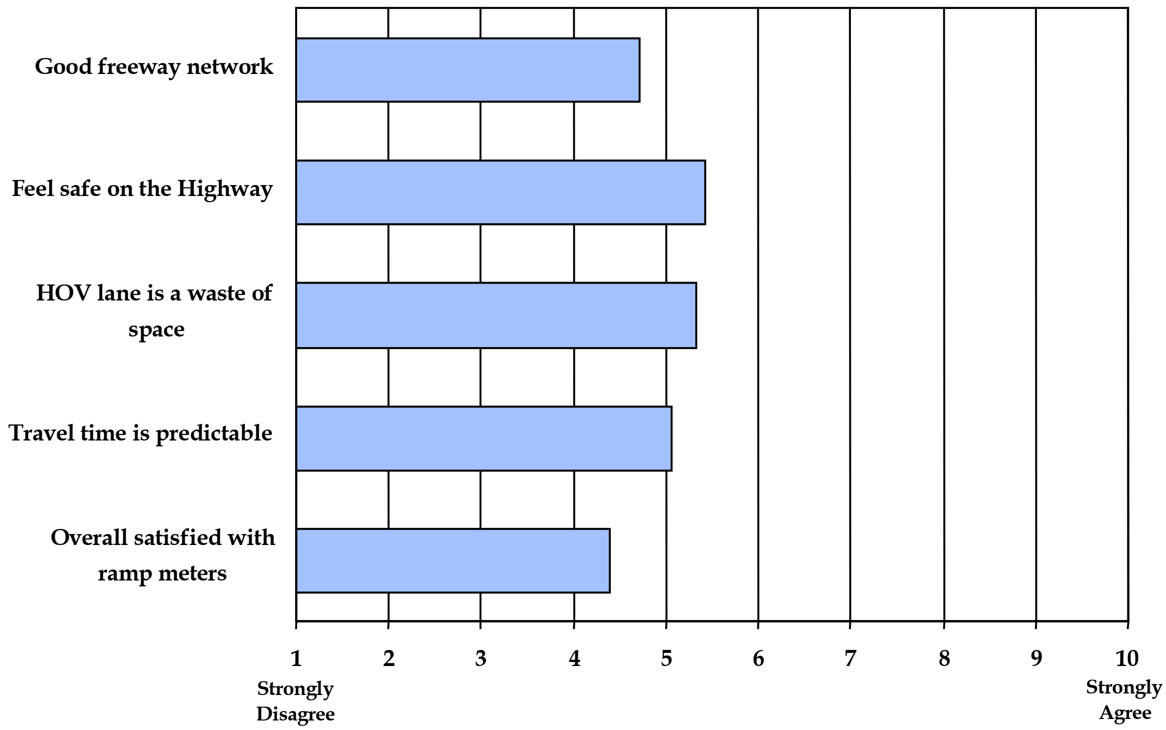
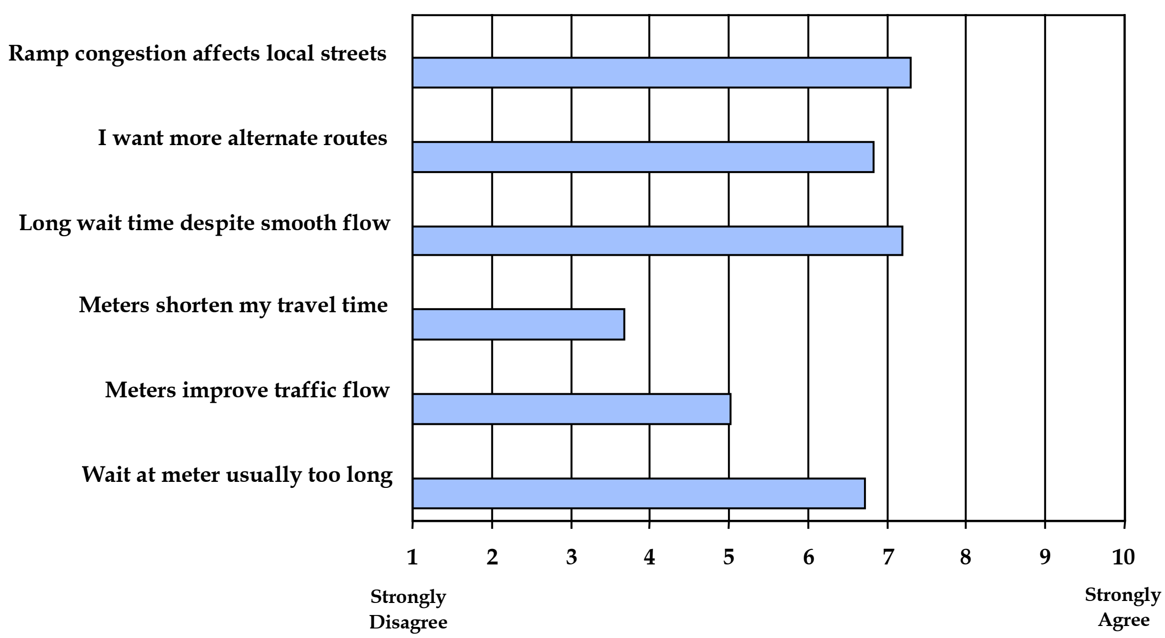


Figure 6.15 Attitudes Toward Ramp Metering
"With Ramp Meters" Corridor Surveys (N=507)



performance. This pattern is consistent with the insights from the focus groups, where participants were dissatisfied mostly with ramp meters, rather than with their overall travel experience.

Overall, the responses to the attitudinal questions in the random survey were comparable to the corridor survey, although the random survey ratings were generally a little more positive toward ramp metering. A detailed list of average ratings for the random sample and the four corridor surveys is provided in Appendix H.

Differences by Corridor: There were some interesting differences in the perceptions of commuters using different corridors with I-94 commuters being the most positive about metering, and commuters on I-35W being the most vocal against the metering system.

- I-494 users generally "felt safe driving on the freeway," but
  - Didn't believe that "during peak traffic their travel times were predictable,"
  - Thought that the wait time at the meters was too long, and
  - Gave the lowest rating for "overall satisfaction with ramp metering."
- Commuters on I-35E stated that they "never know how long to wait" and gave lower ratings to "feeling safe when merging with freeway" and "feeling safe when leaving the ramp to merge."
- Users of the I-35W corridor
  - Gave the lowest ratings for "overall satisfaction with ramp metering";
  - Believed strongly that "ramp meters affect local streets," that they "never know how long they'll wait," and that "wait times at meters are too long";
  - Wished they had "more alternate routes to avoid ramp metering," and were much less receptive to the usefulness of HOV lanes; and
  - Disagreed more than the other corridor users with the statement that "ramp meters reduce crashes" and that they "feel safe when merging with freeway."
- Finally, commuters on the I-94 corridor generally provided positive feedback for the ramp meter system since they:
  - Believed that the "cost of ramp meters is a good value";
  - Agreed more than the rest that "meters improve overall traffic flow" and that "meters shorten my travel time"; and
  - Were less likely to believe that they "had to wait at a ramp even when freeway traffic was moving smoothly," while they were more receptive to HOV lanes.

Differences by Market Segment – In addition to the identified differences by corridor, an effort was undertaken to identify differences by market segments. Both socioeconomic and travel-related variables were used to examine whether some of the observed differences by survey wave could be attributed to differences by underlying market segments.

The socioeconomic variables that were tested included respondents' gender, age, education, employment status, household size, and household income. The travel-related variables that were tested included frequency of travel, travel in the a.m. versus the p.m. peak period direction, reported wait times at the ramp, and total and freeway travel time.

The most important statistically significant differences that could be attributed to socioeconomic and travel characteristics related to the length of the total origin-destination trip. Travelers with longer travel times of 45 minutes or more:

- Provided lower ratings for the statement that "during peak traffic hours my travel time is predictable";
- Were more satisfied with the "overall operation of ramp meters" and were less in agreement with the statements that "the wait at ramp meters is usually too long," and that "sometimes I need to wait at a ramp meter for a long time even when the highway traffic seems to be moving well";
- Believed that "ramp meters improve overall traffic flow" and that "meters shortened their travel time"; and
- Although they felt less "safe from crashes on the freeways," they agreed that "meters reduce car crashes" and that the ramp meter system was a good value.

The longer wait times experienced at ramp meters helped to explain respondents' lower ratings for the "freeway network in the Minneapolis/St. Paul area," their disagreement with the statement that "meters reduce my travel time," and their lower level of "overall satisfaction with ramp metering."

Finally, there were also some important gender-specific differences that related to ramp meter operations. In particular, women:

- Felt less "safe from crashes on the freeway";
- Agreed less than men with the statement that they "felt safe when leaving the ramp to merge into the freeway";
- Believed more than men that "meters reduce car crashes";
- Agreed more strongly than men that "meters improve traffic flow"; and
- Were more receptive to the concept of a changeable message sign before the ramp entrance providing information about the expected ramp wait time.

6.8 Differences in Attitudes Following the Shutdown

The primary objective of the comparative analysis of traveler's ratings of highway performance before and after the experimental shutdown of ramp meters was to evaluate whether and how the experiment had affected travelers' attitudes. The first step in the analysis was to examine whether the ramp metering shutdown experiment had affected respondents' general perceptions about travel in the study area and, more specifically, how it had affected their perceptions about ramp meter performance. The second step was to identify whether the experiment had affected various market segments in different ways. To examine that, the analysis also focused on identifying corridor-specific and travel-related influences on travelers' changing attitudes.

This section presents and discusses only those differences that are statistically significant at the 95-percent confidence level. The t-statistic test and analysis of variance methods were used to identify those differences that were statistically significant.

Table 6.9 summarizes the statistically significant differences that were identified for respondents' "with ramp meters/without ramp meters" attitudes in the random sample and across corridors. Appendix H includes five tables that show each individual rating in the "with ramp meters" and "without ramp meters" surveys in the random sample and the four corridors along with the corresponding t-statistic values. This section provides an overview of the results of the random sample survey and then focuses on the corridor-specific differences that have emerged.

The changing pattern of attitudes shown in Figure 6.16 highlights the impact of the ramp meter shutdown on travelers' perceptions. These statistically significant differences from the corridor sample underscore the strengthening of the already negative perceptions toward ramp metering among the corridor users.

Random Sample Survey – The "with ramp meters/without ramp meters" changes in ratings presented in Table 6.9 strongly suggest that randomly selected respondents in the Minneapolis/St. Paul metro area:

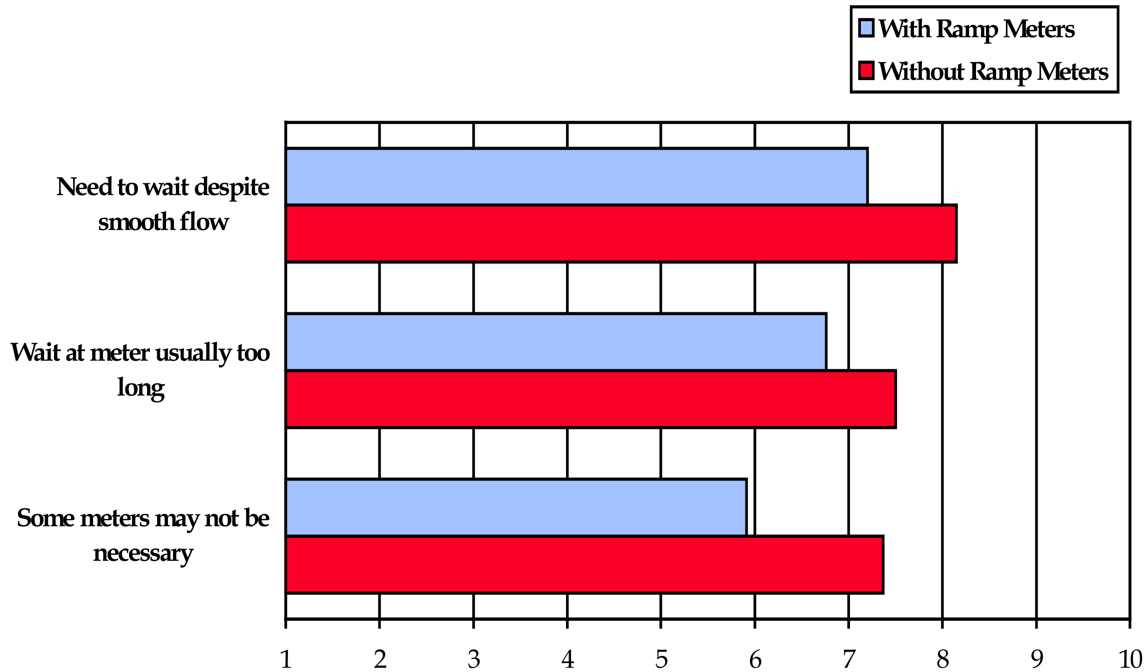
- Have reinforced their negative perceptions that "the length of ramp meter wait times was too long";
- Are more convinced than they used to be before the shutdown that "some meters may not be necessary";

Table 6.9 Statistically Significant Differences in Travelers' Attitudes N=250 in Each Corridor and N=500 in the Random Sample

	Random	I-494	I-35E	I-35W	I-94
Need to wait despite smooth flow	+0.8	+0.3	+0.9*	+1.3	+1.5
Wait at meters is too long	+0.7	-0.1	+1.0	+0.7	+1.4
Some meters not necessary	+1.5	+0.6	+1.6	+1.8	+1.6
Travel time is predictable	+0.2	+0.1	+1.1	+0.6	-0.3
Congestion more tolerable	+0.7	+0.3	+2.1	+1.0	0.0

*Note: Statistically significant differences in red. It should be noted that tests of statistical significance involve several measures of variance across the sample. Thus, a change of 1.0 could be statistically significant in one case, but not in another.

Figure 6.16 "With Ramp Meters/Without Ramp Meters" Wait Time Attributes and Need for Meters – N=906 for Corridor Surveys



- Believe firmly now that "they had to wait too long at a ramp even when freeway traffic was moving smoothly";

- Believe that the "level of congestion" that they face in their after commute after the shutdown is more tolerable than before the meter shutdown; and

- Seem to agree less than they used to about the value of the "VMS signs informing them of the expected ramp wait times."

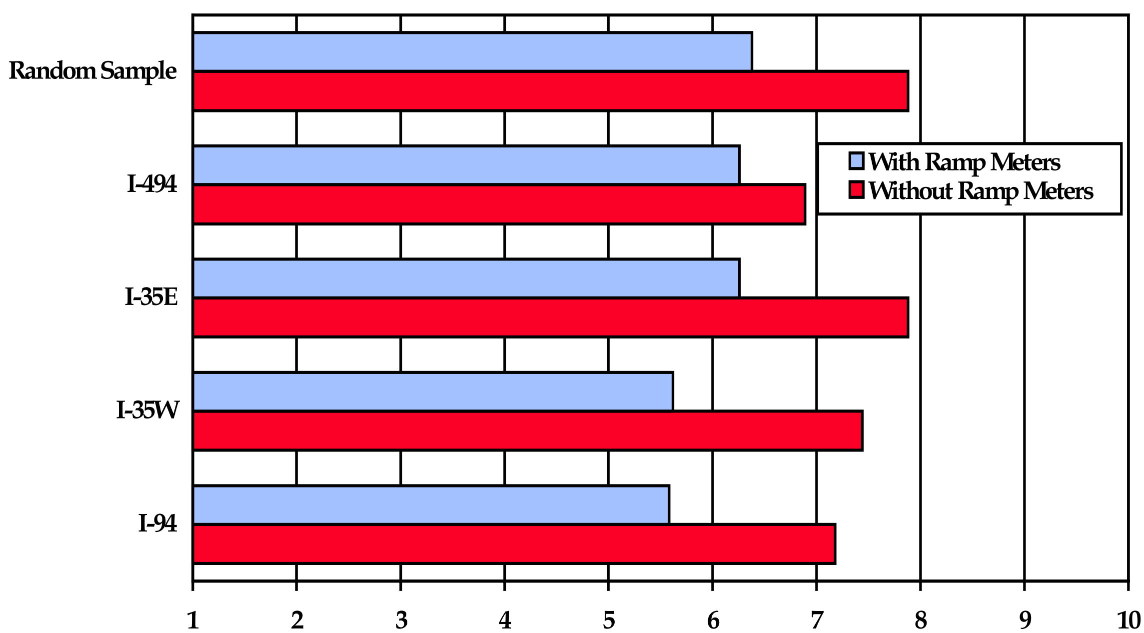
These findings most likely reflect the relatively smooth operation of the freeway system during the experimental shutdown. Despite the increase in travel times and the change in accident rates, the ramp meter shutdown did not cause a major gridlock in the area and traffic continued to flow reasonably well without the need to wait at ramp meters.

Differences by Corridor – The analysis of the attitudinal ratings across the four corridors provided some interesting insights. Since the picture that emerged was quite different across the four corridors, the following discussion focuses on the statistically significant differences for each corridor while a detailed listing of all attitudinal differences is provided in Appendix H.

Commuters using the I-35E, I-35W, and I-94 corridors were in agreement among themselves, but in sharp contrast to I-494 users. The "without ramp meters" ratings provided by commuters on the I-35E, I-35W, and I-94 corridors, when compared with their "with ramp meters" ratings, clearly suggest that the experiment has reinforced their negative perceptions about ramp meter operations (Table 6.9). In particular, commuters on each of these three corridors were in agreement with the random sample respondents since:

- They became more convinced that "some meters may not be necessary" (Figure 6.16);
- They believed strongly that "the length of ramp meter wait times was too long."
- They now believed firmly that when the meters were in operation they had to wait too long even when freeway traffic was moving smoothly.
- The pattern of "with ramp meters/without ramp meters" differences by corridor for each of these statements is the same as the pattern shown in Figure 6.17. In addition, commuters on I-35E and I-35W also believed that:
  - The predictability of their commute had improved significantly during the experimental meter shutdown, and
  - Their commute on I-35W and I-35E was considerably more tolerable than it used to be when the ramp meters were in operation.

Figure 6.17 Differences in "Some Meters May Not Be Necessary" by Corridor N=250 in Each Corridor and N=500 in the Random Sample



Finally, there was an interesting finding regarding corridor I-35W that was not consistent with I-35E corridor users' overall negative view of ramp meters. As shown in Table 6.10, I-35W commuters appreciated the safety aspects associated with ramp metering. In particular:

- They believed that the operation of ramp meters made them "feel safe when leaving a ramp meter and merging into freeway traffic"; and

- They agreed with the statement that "ramp meters reduce car crashes."

As part of the safety analysis, it would be very interesting to identify whether there was a higher incidence of accidents on I-35W that could be attributed to the ramp meter shut-down, and whether the configuration of the freeway entrance ramps on I-35W makes merging more difficult in this corridor compared to the rest of the ramps in the study area.

After comparing their prior experience with the operation of the network system with the ramp meters shut down, I-494 commuters believe that they were better off with the ramp meters in operation (Table 6.10). The pattern of responses by I-494 commuters is in sharp contrast to the responses by commuters in the other corridors as described above. In particular:

- I-494 users were more satisfied with the "overall performance of ramp meters."

- They appreciated more the element of safety that ramp meters provide giving higher ratings to the statements "feeling safe when leaving the ramp to merge into the high-way" and "ramp meters reduce car crashes."

Table 6.10 Statistically Significant Differences for I-494 Corridor N=250 in Each Corridor and N=500 in the Random Sample

	Random	I-494	I-35E	I-35W	I-94
Overall satisfied with meters	-0.3	+1.4	-0.2	-0.1	-0.7
Meters improve overall traffic	-0.1	+1.5	+0.2	+0.4	-0.6
Meters shorten travel time	0.0	+2.0	+0.4	0.0	+0.1
Feel safe to merge	+0.3	+0.8	+0.4	+1.4	-0.1
Meters reduce car crashes	+0.1	+0.7	+0.4	+0.7	-0.8

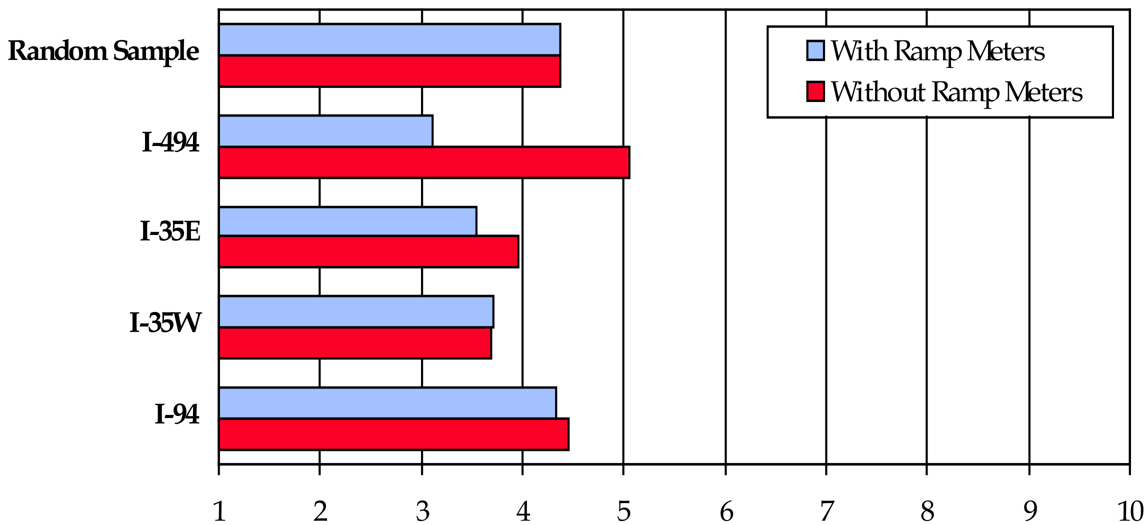
*Note: Statistically significant differences in red.

- They believed more strongly than before that "ramp meters shortened my travel time" as shown in Figure 6.18.

- They agreed more strongly with the statement that "ramp meters improve overall traf-fic flow" in the corridor.

- They didn't believe as strongly any more that "buses and carpools should have bypass lanes." The patterns of attitudinal differences for each of these statements followed the pattern shown in Figure 6.18.

Figure 6.18 Differences in "Meters Shorten my Travel Time" by Corridor N=250 in Each Corridor and N=500 in the Random Sample



The negative experience of I-494 commuters during the meter shutdown and their more positive view of ramp meters is consistent with I-494 users' evaluation of worsening traffic conditions and longer travel times during the shutdown as discussed in Section 6.5. Their perceptions also reflect the increase in travel time in the corridor as measured by the I-494 travel time runs and the higher variability of speeds in the I-494 corridor. These findings are also consistent with the travel pattern profile of I-494 users having longer average trip times than those surveyed in the other corridors, and having origins further from the urban core. These are precisely the groups which would generally be expected to benefit from ramp metering. This premise is further reinforced by the following comparison of attitudes toward ramp metering by trip length across the entire survey sample.

Differences by Travel Attributes – Finally, an examination of the impacts of travel-related attributes on travelers' perceptions uncovered some additional important differences among travelers with commutes of different lengths. In particular, respondents with longer origin-destination travel times changed their perceptions of ramp meter operations differently than respondents who took shorter trips.

In the "without ramp meters" survey, satisfaction with ramp meter operations has increased among travelers with longer commutes. The longer their travel time, the more likely it is that travelers come to realize that they were better off with the meters in operation, a pattern that was the reverse for commuters with short O-D travel times. Two figures are included here as examples of the travel time impact on the change in travelers' perceptions about ramp meters, but the pattern of more positive perceptions is the same and very strong in all five statements:

1. "Overall I am satisfied with the ramp meter system" as shown in Figure 6.19.
2. "Ramp meters shorten my travel time overall" shown in Figure 6.20.

Figure 6.19 "Overall Satisfied With Meters" by Travel Time Market Segments N=903 in the Corridor Sample

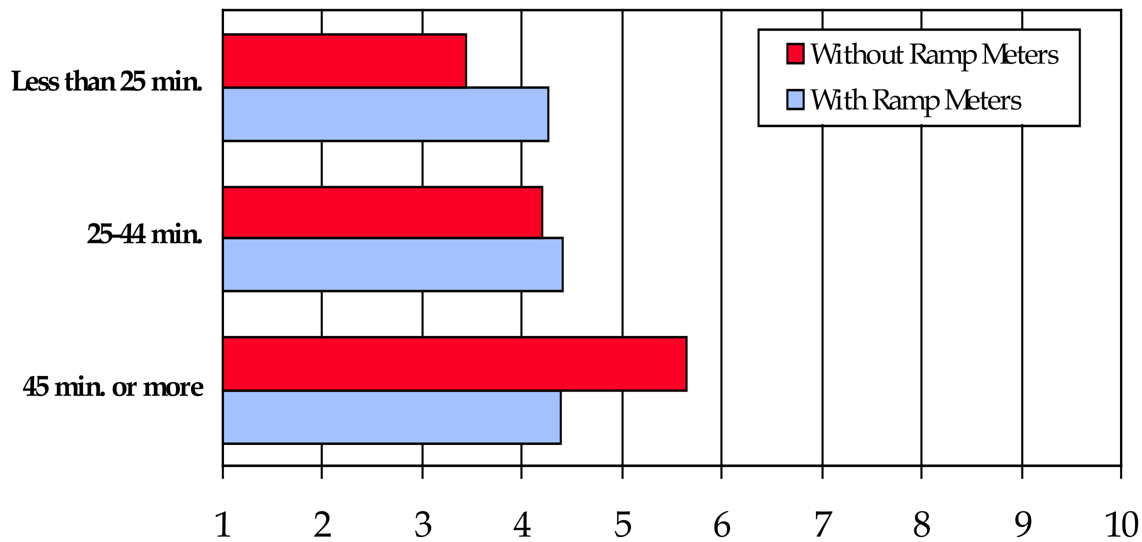
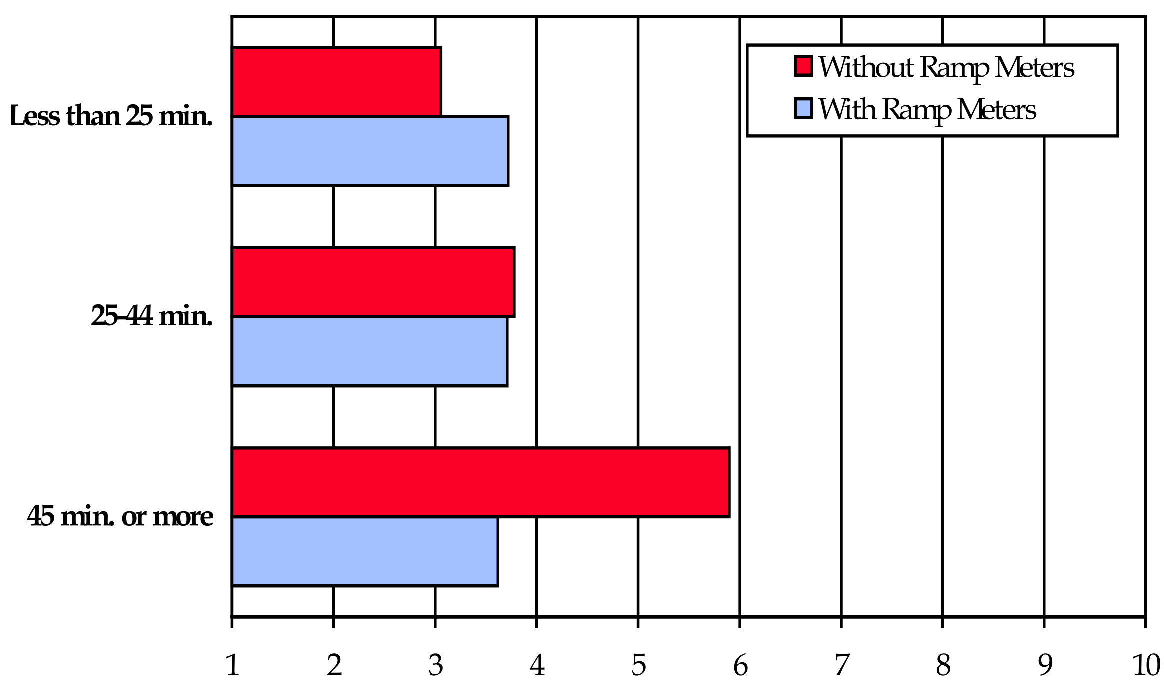


Figure 6.20 "Meters Shorten my Time" by Travel Time Market Segments N=903 in the Corridor Sample



3. "Ramp meters improve the area's overall traffic flow."
4. "The length of the time I wait at meters is usually too long."
5. "The cost of ramp meters is a good value to taxpayers."

These patterns confirm that, although travelers with longer trips were originally more positive toward ramp metering, the experience of the ramp meter shutdown strengthened their positive view of metering even further.

6.9 Travelers' View of the Ramp Metering Future

The final objective of the market research was to assess whether respondents favored changes to the ramp metering system; to identify proposed changes; and to examine differences by survey wave, corridor, and market segment. At the end of both the "with ramp meters" and "without ramp meters" surveys, respondents were asked to evaluate the ramp metering system with the following question:

> *"Given your experience with the ramp meter system in the Minneapolis/St. Paul area, do you think the ramp meter system should be continued as it is now, modified in some way, or shut down permanently?"*

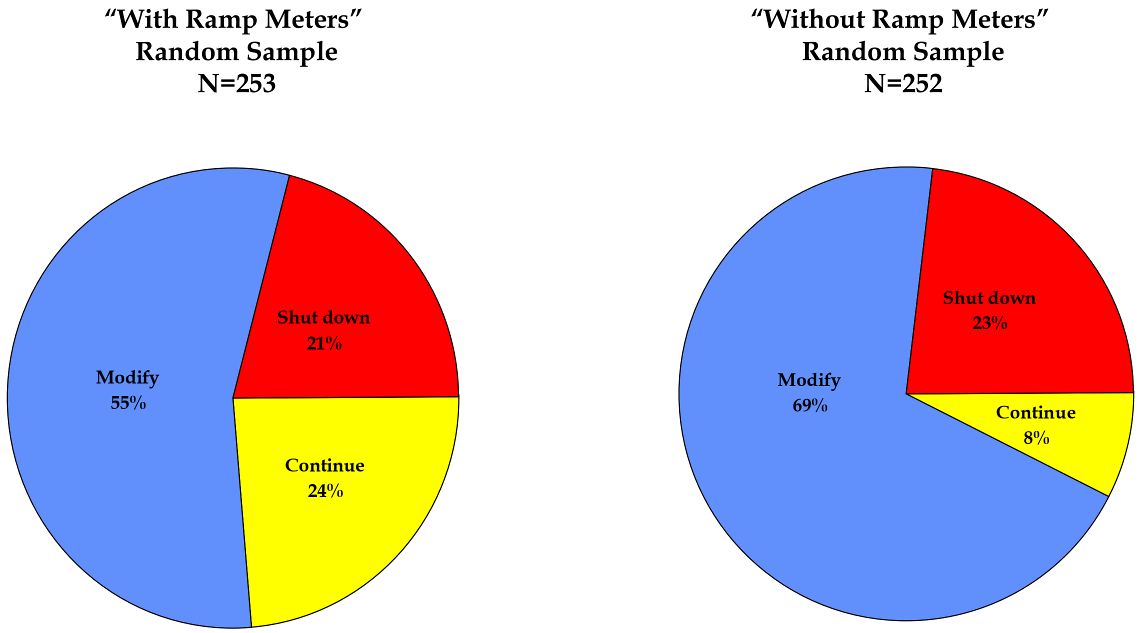
The three responses to the question (status quo versus shutdown versus modifications) were rotated to minimize any response bias that could be attributed to ordering effects.

The analysis of both the "with ramp meters" and "without ramp meters" responses suggests that respondents strongly favor a modified version of the ramp metering system. The differences by survey wave show increasing support for the "modification" option following the shutdown, while differences across corridors and market segments suggest that I-494 users and those making longer trips are more supportive of the pre-shutdown status quo.

Traveler Preferences – As shown in Figure 6.21, prior to the shutdown, more than half of the random sample respondents wanted the ramp meter system modified with the rest split almost equally among those who favored the status quo (24 percent of the total) and those who wanted the system shut down permanently (21 percent of the total). The strongest support for the meter shutdown was among frequent travelers driving alone in the corridor and facing ramp wait times eight minutes or longer.

Following the shutdown, the "modification" option strengthened even further supported by a dominant 69 percent of the random sample respondents. The support for maintaining the meter system status quo was down considerably from 24 percent of the random sample to just eight percent in the "without ramp meters" survey. It should also be noted that the percentage of respondents favoring a permanent shutdown remained more or less constant over the two survey waves.

Figure 6.21 Future of Ramp Metering – Random Sample



Similar patterns were also observed for the corridor survey sample (Figure 6.22). Support for the "modification" option among the four corridor users dominated both survey waves, rising from 59 percent to 70 percent of the sample following the shutdown. Support for the ramp meter status quo dropped over time with only 11 percent of the corridor users supporting it, following their generally positive experiences with the ramp meter shutdown.

Differences by Corridor and Market Segment – The analysis of respondents across the four corridors and across market segments uncovered some additional interesting differences. The common finding was that the majority of corridor users want the system modified in some way, with that option gathering greater support following the shutdown and mostly at the expense of the status quo option.

In three out of the four corridors, support for the ramp meter status quo dropped dramatically following the shutdown (Figure 6.23). In the I-35E corridor, only 5.5 percent of the users want the meters back compared to 18 percent in the "with ramp meters" sample. Similarly, in the I-35W corridor, the support for the status quo drops from 13 percent to eight percent, while in the I-94 corridor from a previous high of 32 percent to 13 percent. In contrast, support for the status quo increased among I-494 users from a previous low of 13 percent to a post-shutdown high of 17 percent.

This pattern was examined further to identify the reasons behind it. As shown in Figure 6.24, total travel time helps to explain the differences in travelers' responses. More than 90 percent of travelers with a typical commute travel time of less than 25 minutes

Figure 6.22 Future of Ramp Metering – Corridor Sample

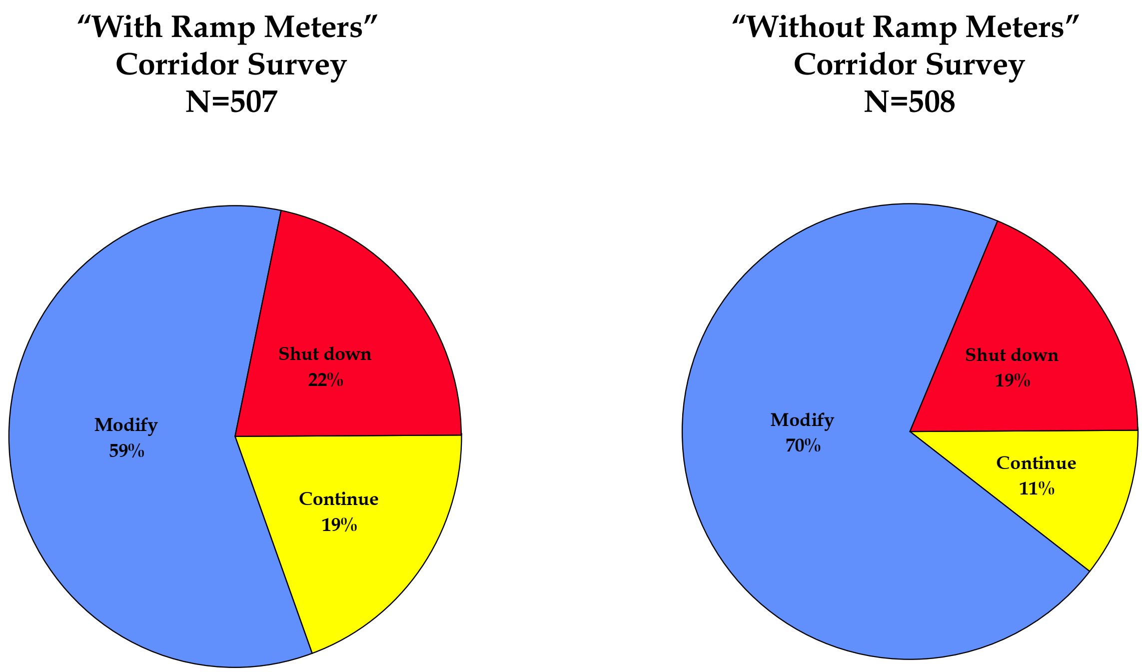


Figure 6.23 Future of Ramp Metering – Random Sample

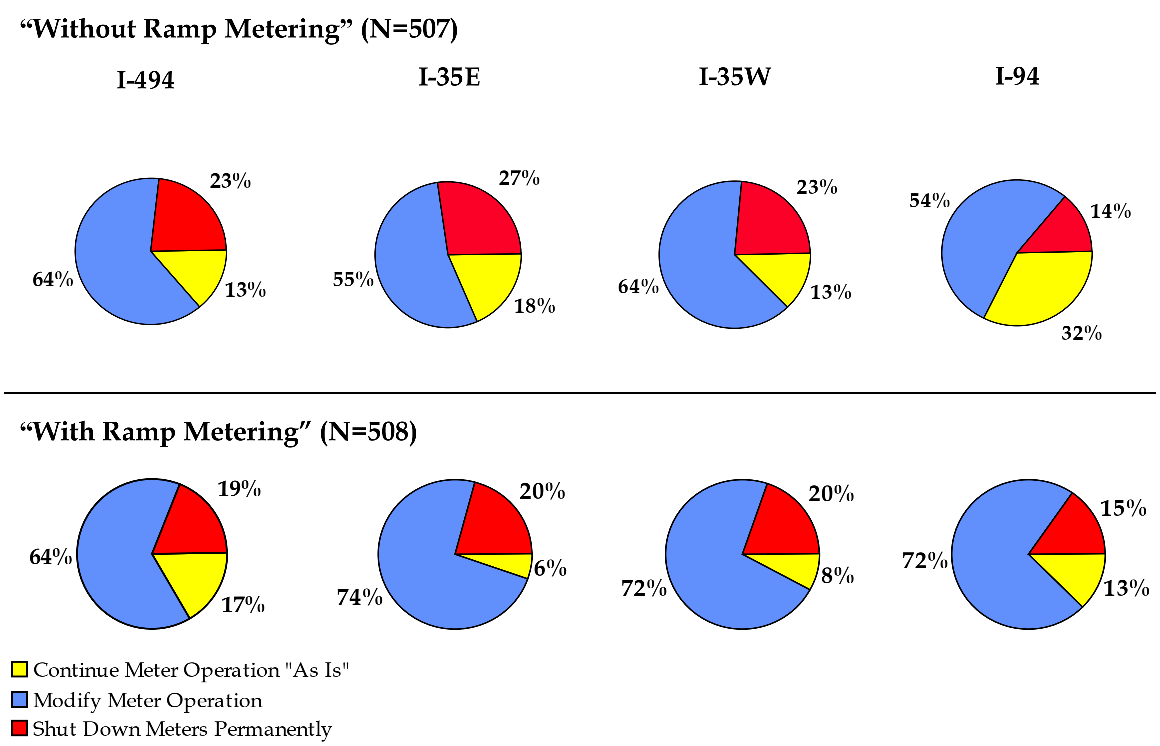
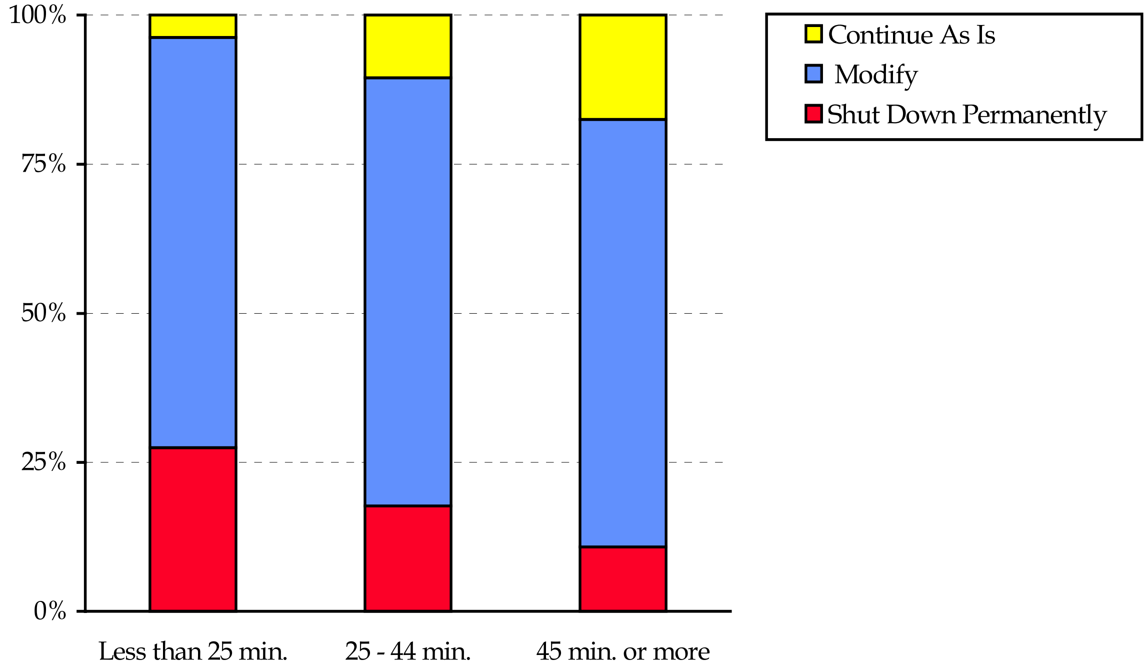


Figure 6.24 Differences in Future of Ramp Metering by Total Travel Time "Without Ramp Meters" Corridor Surveys (N=508)



were strongly opposed to the status quo and wanted the meters either shut off permanently or modified in some way. In contrast, travelers with typical commute times of more than 45 minutes were much more likely to prefer the status quo and much less likely to want the meters shut down permanently. This finding is consistent with the greater support for the status quo among I-494 commuters who experience a longer commute than respondents in the other three corridors.

Suggested Modifications – Finally, respondents who favored a modified version of the ramp meter system were asked to provide their own suggestions. The question was open-ended and respondents could provide one or more suggestions for improvement of the system. These responses were later categorized by the study team to provide an overview of respondents' preferences.

Table 6.11 shows the suggested modifications that were mentioned at least 10 percent of the time in the "with ramp meters" survey. Actions that are related to reducing the wait time experienced at the ramp meters topped the list representing 50 percent of the responses in the "with ramp meters" survey. Shortening the hours of operation and reducing the number of meters keeping meters only in congested areas were also frequently mentioned, followed by the option of providing electronic sign information about ramp delays before the ramp entrance.

Table 6.11 Ramp Metering Modifications – All "With Ramp Meters" and "Without Ramp Meters" Surveys

	With Ramp Meters	Without Ramp Meters
Shorten wait times/turn green faster	26%	25%
Adjust green to light traffic flow	24%	17%
Shorten hours of operation/turn off	16%	14%
Fewer meters/only in congested areas	15%	49%
Sign at ramp entrance	10%	6%

Interestingly, the pattern of responses was somewhat different in the "without ramp meters" survey. The dominant suggestion mentioned almost 50 percent of the time was to reduce the number of meters by focusing only in congested areas. This pattern is consistent with the drop in respondents' preference for the status quo and their increased support for modifications. These patterns are more clearly demonstrated by Table 6.12 which highlights differences by corridor. It is interesting to note that I-494 commuters prefer adjustments to the existing system of ramp meters mostly by suggesting actions that reduce wait times at the meters. In contrast, half or more of the commuters in each of the other three corridors favor a reduction in the meters in operation with ramp metering focused only in areas with existing traffic congestion.

Table 6.12 Ramp Metering Modifications – "Without Ramp Meters" Surveys by Corridor

	I-494	I-35E	I-35W	I-94
Shorten wait times/turn green faster	35%	21%	27%	18%
Adjust green to light traffic flow	28%	10%	16%	16%
Shorten hours of operation/turn off	27%	10%	8%	12%
Fewer meters/only in congested areas	22%	49%	64%	59%